Bureau of Land Management

Reno, Nevada

Human Health Risk Assessment

Final Report

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LIST OF ACRONYMS, ABBREVIATIONS, AND SYMBOLS

a.i.	-	active ingredient
AC	-	Concentration of Active Ingredient in Concentrate
ANS	-	Accession Number System
AR	-	Application Rate
ARI	-	Aggregate Risk Index
AT	-	Acres Treated
ATV	-	All-terrain Vehicle
BCF	-	Bioconcentration Factor
BLM	-	Bureau of Land Management
BR	-	Berry Residue
BW	-	Body Weight
CalEPA	-	California Environmental Protection Agency
CBI	-	Confidential Business Information
CF	-	Conversion Factor
CREAMS	-	Chemical Runoff Erosion Assessment Management System
CRP	-	Conservation Reserve Program
CSF	-	Cancer Slope Factor
DAF	-	Dermal Absorption Factor
DFR	-	Dislodgeable Foliar Residue
DR	-	Deposition Rate
EF	-	Exposure Factor
EFH	-	Exposure Factors Handbook
EIS	-	Environmental Impact Statement
EPC	-	Exposure Point Concentration
ERA	-	Ecological Risk Assessment
ET	-	Exposure Time
F	-	Fraction
FQPA	-	Food Quality Protection Act
GLEAMS	-	Groundwater Loading Effects of Agricultural Management Systems
HDT	-	Highest Dose Tested
HED	-	Health Effects Division
HHRA	-	Human Health Risk Assessment
HSDB	-	Hazardous Substances Data Bank
IAF	-	Inhalation Absorption Factor
IR	-	Ingestion Rate
IRIS	-	Integrated Risk Information System
Kp	-	Dermal Permeability Constant
LC_{50}	-	Median Lethal Concentration
lb	-	Pound
LD_{50}	-	Median Lethal Dose
LDT	-	Lowest Dose Tested
LOAEL	-	Lowest Observable Adverse Effect Level
mg/kg	-	milligrams per kilogram
mg/kg-day	-	milligrams per kilogram of body weight per day
mg/L	-	milligrams per Liter
mg/lb	-	milligrams per pound
MOE	-	Margin of Exposure
MRID	-	Master Record Identification
NAS	-	National Academy of Sciences

LIST OF ACRONYMS, ABBREVIATIONS, AND SYMBOLS (Cont.)

NASA	-	National Aeronautics and Space Administration
NMF	-	N-Methyl Formamide
NOAEL	-	No Observable Adverse Effect Level
OEHHA	-	Office of Environmental Health Hazard Assessment
OPP	-	Office of Pesticide Programs
PAD	-	Population Adjusted Dose
PHED	-	Pesticide Handlers Exposure Database
PPE	-	Personal Protective Equipment
ppm	-	parts per million
RED	-	Reregistration Eligibility Decision
RfD	-	Reference Dose
S	-	Spill amount
SA	-	Surface Area
SAR	-	Surface Area Ratio
SDTF	-	Spray Drift Task Force
SF	-	Safety Factor
SOP	-	Standard Operating Procedure
Tc	-	Transfer coefficient
USDI	-	U.S. Department of the Interior
UE	-	Unit Exposure
UF	-	Uncertainty Factor
USEPA	-	United States Environmental Protection Agency
USLE	-	Universal Soil Loss Equation

EXECUTIVE SUMMARY

The U.S. Department of the Interior Bureau of Land Management (USDI BLM) is prepaing a *Vegetation Treatment Using Herbicides on Bureau of Land Management Lands in 17 Western State Programmatic Environmental Impact Statement* (PEIS) to evaluate proposed vegetation treatment methods and alternatives on public lands managed by the BLM in the western continental US and Alaska. As part of the PEIS, a human health risk assessment (HHRA) was conducted to evaluate potential human health and environmental risks that may result from exposure to herbicide active ingredients (a.i.) both during and after treatment of public lands. The HHRA has evaluated the following six herbicide a.i.:

- Dicamba (as formulated with diflufenzopyr)
- Diflufenzopyr (as formulated with dicamba)
- Diquat
- Fluridone
- Imazapic
- Sulfometuron methyl

The HHRA evaluates the risks to humans from six a.i. (sulfometuron methyl, imazapic, diflufenzopyr, dicamba, diquat, and fluridone) because the other a.i. considered in the PEIS were already quantitatively evaluated in previous BLM EISs (e.g., USDI BLM 1985, 1987, 1988, 1989, 1991), or by the U.S. Department of Agriculture Forest Service (U.S. Department of Agriculture [USDA] Forest Service (Syracuse Environmental Research Associates, Inc. [SERA] 2005). These a.i. may be formulated into herbicides under a variety of trade names and manufacturers. Therefore, specific trade names and manufacturers are not discussed in this report, other than to provide reference herbicide labels (Appendix A).

Diflufenzopyr and dicamba are two a.i. that are formulated together in the herbicide, Overdrive®. While dicamba may be used on its own as an herbicide, diflufenzopyr would only be used as a component with dicamba. Based on information provided by the USEPA, it was determined that separate risk assessments would be conducted on dicamba and diflufenzopyr in the HHRA. While these a.i. are applied together, there are no appropriate toxicological data with which to evaluate the mixture. Furthermore, dicamba and diflufenzopyr have different toxicological endpoints, indicating that their effects on human health are not additive. In addition, use assumptions in this HHRA are based on the forumulation, rather than on the specific a.i. For example, dicamba could be applied aerially by the BLM as a stand-alone a.i. However, as a formulation with diflufenzopyr, it would not be applied aerially, and thus no aerial application scenarios were considered in this HHRA. The reader is encouraged to review SERA (2004) for the risks to humans from applying dicamba aerially, and for other uses of dicamba that would not apply to its use when formulated with diflufenzopyr.

Based on discussions between the BLM and the U.S. Environmental Protection Agency (USEPA), the HHRA approach was updated from the previous BLM EISs to ensure that it is scientifically defensible, consistent with currently available guidance where appropriate, and meets the needs of the BLM vegetation treatment program.

The HHRA follows the four-step risk assessment paradigm as identified by the National Academy of Sciences (NAS; 1983):

- Hazard Identification
- Dose-response Assessment
- Exposure Assessment

- Risk Characterization

Hazard Identification

The Hazard Identification section provides information on the herbicide a.i. characteristics and usage, and toxicity profiles. The toxicity profiles include information on acute, subchronic, and chronic toxicity studies, reproductive and developmental toxicity studies, results of cancer bioassays, mutagenesis, and metabolism. The USEPA's acute toxicity categories are I, II, III, and IV representing severe, moderate, slight, and very slight toxicity. The criteria considered are oral, inhalation, and dermal acute toxicity, eye irritation, skin irritation, and dermal sensitization. For most of the criteria, the herbicide a.i. evaluated in this HHRA are in toxicity categories III and IV. Dicamba is in toxicity category III for acute oral and acute dermal effects, in toxicity category IV for acute inhalation effects, and in toxicity category II for primary eye and primary skin effects. Diquat is in toxicity category II for acute dermal and eye irritation, and fluridone is in toxicity category II for eye irritation. The USEPA has not developed acute toxicity categories for sulfometuron methyl. None of the six herbicide a.i. are designated as potential carcinogens by the USEPA.

Dose-response Assessment

For pesticide risk assessments, noncarcinogenic effects are evaluated differently depending on whether the exposure is dietary or non-dietary. Dietary exposures are evaluated by dividing site-specific herbicide a.i. intakes by a Population Adjusted Dose (PAD). The results are expressed as %PADs. The %PAD approach was used to evaluate public receptor ingestion of drinking water, berries, and fish. Non-dietary exposures are evaluated by dividing a No Observable Adverse Effects Level (NOAEL) by the site-specific intake to calculate a Margin of Exposure (MOE). The MOEs are typically compared to a target MOE of 100, unless specified otherwise. NOAELs are available for a variety of exposure durations and exposure routes. The NOAEL approach is used to evaluate the occupational receptors and the public receptors for the following scenarios: dermal contact with spray, dermal contact with foliage, dermal contact with water while swimming, and incidental ingestion of water while swimming.

For each of the six herbicide a.i. evaluated in this HHRA, the USEPA has developed NOAELs for a majority but not all of exposure durations and exposure routes.

Exposure Assessment

The exposure assessment involves identifying receptors and exposure scenarios and quantifying exposures. To understand how humans may be exposed to herbicide a.i. as a result of the BLM vegetation treatment program, it is necessary to understand herbicide use within the BLM. Within the BLM vegetation treatment program, public lands are classified into various land programs (rangeland, public domain forestland, energy and minerals sites, rights-of-way, recreation and cultural sites, and aquatic sites). Within each program, aerial-, ground-, or boat-based applications may be used. Various application vehicles can be used for each application type, and for each vehicle, there are different application methods. Similarly, there are different BLM job descriptions associated with each application method. It is assumed that occupational receptors may be incidentally exposed to the herbicide a.i. through dermal contact and inhalation exposure routes. In addition, an accidental spill scenario was evaluated for the occupational receptors, assuming a direct spill of herbicide a.i. on the skin.

Members of the public may also be incidentally exposed to herbicide a.i. used on public lands. Such receptors include hikers, hunters, berry pickers, swimmers, anglers, area residents, and Native Americans using natural resources on public lands. Although there are many different exposure scenarios and receptors that could be evaluated, these receptors cover a range of potential exposures that could occur under worst case conditions on BLM lands. It is assumed that these receptors could be exposed through one or more of the following exposure pathways:

- Dermal contact with spray
- Dermal contact with foliage
- Dermal contact with water while swimming
- Ingestion of drinking water or incidental ingestion of water while swimming
- Ingestion of berries
- Ingestion of fish

Although all public receptor exposures to herbicide a.i. used on public lands are considered to be accidental, public receptor exposures are evaluated under two scenarios. Routine-use exposures are assumed to occur when public receptors come into contact with environmental media that have been impacted by spray drift. Accidental exposures are assumed to occur when public receptors come into contact with environmental media that have been subject to direct spray or spills. Under the direct spray scenarios, it is assumed that a receptor enters a foliated area or a pond (for the aquatic herbicide a.i.) that has recently been treated, even though the area is posted with warning signs. The direct spray pathway for terrestrial herbicide a.i. onto ponds assumes that the herbicide a.i. are accidentally sprayed on the pond.

To quantify exposures, it is necessary to estimate the herbicide a.i. concentrations to which receptors could be exposed. For the occupational receptors, routine exposures were calculated using unit exposure (UE) values developed by USEPA combined with the herbicide a.i. application rates (ARs) and the acres treated (AT) per day. Accidental exposures were calculated using the undiluted herbicide a.i. concentrations for liquid formulations and application-ready concentrations for solid formulations, and assuming a certain amount of spill and absorption through the skin.

For the public receptors, routine exposures from spray drift were calculated using exposure point concentrations (EPCs) developed using computer models. The AgDRIFT® model was used to estimate deposition of herbicide a.i. drift onto the receptor, foliage, berries, and pond. The GLEAMS model was used to calculate herbicide a.i. concentrations in the pond resulting from runoff (short-, intermediate-, and long-term exposure durations). For the terrestrial herbicide a.i., pond concentrations calculated in AgDRIFT® were added to the highest pond concentrations calculated in GLEAMS. Accidental exposures were calculated assuming direct spray of the herbicide a.i. at the maximum ARs onto the receptor, foliage, berries, and pond. In addition, an accidental spill scenario was evaluated for the pond assuming that the entire contents of a truck or helicopter could spill into the pond.

Risk Characterization

The risk characterization section provides quantitative risk estimates for each of the herbicide a.i. for the various receptors and exposure scenarios. USEPA's Office of Pesticide Programs (OPP) has developed an Aggregate Risk Index (ARI) approach that combines risks calculated using the %PAD and MOE methods. As with the MOE, potential risk increases as the ARI decreases. The ARI is compared against a target value of 1. Values greater than 1 do not exceed the USEPA's level of concern.

Diquat results in ARIs less than 1 for a majority of the occupational receptors and public receptors, indicating a level of concern. Fluridone results in ARIs less than 1 for several of the occupational and public receptors under the maximum AR scenarios. Dicamba, diquat, and fluridone result in ARIs less than one for the occupational accidental spill scenario (spill to worker skin). The other three herbicide a.i. (diflufenzopyr, imazapic, and sulfometuron methyl) do not result in ARIs below 1 for any scenario, indicating no level of concern with use of these three herbicide a.i.

1.0 INTRODUCTION

The U.S. Deparment of the Interior Bureau of Land Management (USDI BLM) is preparing a *Vegetation Treatment Using Herbicides on Bureau of Land Management Lands in 17 Western State Programmatic Environmental Impact Statement* (PEIS) to evaluate proposed vegetation treatment alternatives on lands managed by the BLM (public lands) in the western continental U.S. and Alaska. This PEIS updates the following four EISs developed by the BLM in the mid 1980s and early 1990s:

- Northwest Area Noxious Weed Control Program – 1986
- California Vegetation Management – 1988
- Vegetation Treatment of BLM Lands in Thirteen Western States – 1991
- Western Oregon Program Management of Competing Vegetation – 1992

The treatment alternatives for this PEIS include the use of herbicide a.i. under a variety of application methods. Therefore, as part of the PEIS, a human health risk assessment (HHRA) was conducted to evaluate potential human health risks that may result from herbicide a.i. exposure both during and after treatment of public lands. The four EISs mentioned above addressed the use of herbicide a.i., hereafter referred to as the "present" or "previously-approved" - herbicide a.i. Under the current PEIS, the HHRA evaluates the following six herbicide a.i., most of which are not currently used on public lands, and are hereafter called the "considered" herbicide a.i.:

- Dicamba (formulated with diflufenzopyr)
- Diflufenzopyr (formulated with dicamba)
- Diquat
- Fluridone
- Imazapic
- Sulfometuron methyl

These a.i. may be formulated into herbicides under a variety of trade names and manufacturers. Therefore, specific trade names and manufacturers are not discussed in this report, other than to provide reference herbicide labels (Appendix A). Note that in the HHRA, Overdrive® was only evaluated as its two separate components, dicamba and diflufenzopyr, as these two a.i. have different toxicological endpoints, indicating that their effects on human health are not additive.

Sulfometuron methyl and dicamba are the only herbicide a.i. from the any of the previous EISs that are reevaluated in this HHRA. Sulfometuron methyl has been found to impact non-target vegetation when carried on soil to untreated areas, and these effects were not evaluated in the earlier vegetation treatment EISs. Therefore, a more detailed ecological evaluation of sulfometuron methyl has been included in the PEIS. The HHRA for sulfometuron methyl, as for the other herbicide a.i., includes an evaluation of both application onto target areas as well as off-site to non-target areas.

The remaining previously approved herbicide a.i. are not evaluated in this HHRA because the human health effects of these herbicide a.i. were adequately addressed in the previous EISs. Section 5.4 includes a discussion of the remaining previously approved herbicide a.i.

1.1 HHRA Overview

The risk assessments included in the four previous EISs followed HHRA guidelines as developed by the NAS (1983). Since then, both the USEPA Superfund program (USEPA 1989) and the USEPA Office of Pesticide Programs (OPP; USEPA 2000a) have developed new guidelines for HHRA. While the original scope of work for ENSR's development of the HHRA stated that the template for the report, exposure scenarios, and evaluation would be obtained from the previous EISs, the BLM convened an inter-agency work group from May through October of 2002 to review these methods and compare them with current risk assessment practice. The ultimate goal of these discussions was to reach consensus on updated risk assessment methods to ensure that the risk assessment methodology employed in the current PEIS is scientifically defensible, is consistent with currently available guidance where appropriate, and meets the needs of the BLM vegetation treatment program.

For the HHRA methods discussion, the inter-agency work group consisted of representatives from the BLM, USEPA, and ENSR International, the contractor to the BLM for this HHRA. The HHRA complies with USEPA guidance for conducting risk assessments for pesticides including, but not limited to, the following documents:

- The Role of Use-related Information in Pesticide Risk Assessment and Risk Management (USEPA 2000a)
- Guidance for Performing Aggregate Exposure and Risk Assessments (USEPA 1999a)
- Exposure Factors Handbook (EFH; USEPA 1997a)

1.2 Organization of Document

The HHRA follows the four-step paradigm as identified by NAS (1983). The steps are:

- Hazard Identification
- Dose-response Assessment
- Exposure Assessment
- Risk Characterization

Each of these steps are discussed in the following sections (Sections 2.0 to 5.0). Section 6.0 is the Summary and Conclusions, and Section 7.0 provides the references.

2.0 HAZARD IDENTIFICATION

The purpose of the hazard identification process is to identify and summarize toxicity information for the six herbicide a.i. that are quantitatively evaluated in the HHRA. Section 5.4 includes a discussion of the previously-approved herbicide a.i. and the applicability of previous risk results.

2.1 Chemical Characteristics and Usage

This section provides simple chemical descriptions and usage summaries for the six new herbicide a.i. The BLM and the HHRA project team have compiled application type and rate information specific to BLM practices for each of the six herbicide a.i. This information is discussed in Section 4.0.

2.1.1 Dicamba

According to the approved label (Appendix A), dicamba is a selective postemergence herbicide for the management of annual broadleaf weeds and/or suppression of perennial broadleaf weeds. Activity is also noted for suppression of annual grassy weeds. As a dry, flowable herbicide formulation, a combination of dicamba and diflufenzopyr is mixed with water and is presently registered for use on corn, rangeland, pasture, and noncropland situations. Dicamba kills broadleaf weeds before and after they sprout.

2.1.2 Diflufenzopyr

According to the approved label (Appendix A), diflufenzopyr is formulated with dicamba, and the herbicide is a selective postemergence herbicide for the management of annual broadleaf weeds and/or the suppression of perennial broadleaf weeds. Activity is also noted for suppression of annual grassy weeds. As a dry, flowable herbicide formulation, a combination of diflufenzopyr and dicamba is mixed with water and is presently registered for use on corn, rangeland, pasture, and noncropland situations. Diflufenzopyr acts by inhibiting auxin transport.

2.1.3 Diquat

Diquat, according to a manufacturer's label (see Appendix A), is a nonvolatile chemical for use as a general contact herbicide for the management of weeds in noncropland and aquatic areas. This herbicide manages weeds by interfering with photosynthesis within green plant tissue. In the BLM vegetation management program, diquat will be used only in aquatic areas.

2.1.4 Fluridone

Fluridone, according to a manufacturer's label (see Appendix A), is a selective, systemic aquatic herbicide for the management of aquatic vegetation in freshwater ponds, lakes, reservoirs, drainage canals, and irrigation canals. Fluridone is absorbed from treated water by plant shoots and from hydrosoil by the root systems of aquatic vascular plants. Activity is associated with maintaining a specified concentration of the a.i. in contact with the target species. Inhibition of carotene formation is the identified mechanism of activity for this particular a.i.

2.1.5 Imazapic

Imazapic, according to a manufacturer's label (see Appendix A), is a selective herbicide, presently registered for use on pastures, rangeland, Conservation Reserve Program (CRP) land, noncropland situations, and peanuts. Imazapic can be applied either preemergence or postemergence to the targeted weed species, and acts in the plant by inhibiting the synthesis of selected amino acids. Imazapic is readily absorbed through leaves, stems and roots, and is translocated rapidly throughout the plant, with accumulation in the meristematic regions.

2.1.6 Sulfometuron Methyl

According to a manufacturer's label (see Appendix A), sulfometuron methyl, is a dry, flowable formulation that has activity on many grassy and broadleaf weeds. It is presently registered for weed management in forestry and noncropland situations and has both selective and nonselective activity, depending upon use rates and targeted weed species. Sulfometuron methyl has preemergence and postemergence activity and works within the plant through the inhibition of specific amino acids.

2.2 Toxicity Profiles

This section includes toxicity profiles for each of the herbicide a.i. that summarize the potential toxicity of each of these a.i. and provide information that puts the toxicity into context. The toxicity profiles include information on acute, subchronic, and chronic toxicity studies, reproductive and developmental toxicity studies, cancer bioassays, mutagenicity studies, epidemiology studies, metabolism, and toxicokinetics. Dose-response assessments based on available toxicity information are discussed in Section 3.0.

2.2.1 General Information

Much of the toxicity information discussed in this section is from USEPA reports, such as the Pesticide Fact Sheets or HHRA conducted by the OPP Health Effects Division (HED) to evaluate use of the pesticides on specific crops. In addition, a literature search was conducted to ensure that relevant available information was used in these toxicity profiles. The databases searched include the National Library of Medicine's Hazardous Substances Data Bank (HSDB) and Toxline. The USEPA receives many unpublished toxicity data sets that are referenced in USEPA documents using Master Record Identification (MRID) numbers. This is the USEPA's system of recording and tracking studies submitted to the USEPA and replaces the earlier Accession Number System (ANS). In this HHRA, the MRID or Accession numbers are noted where provided along with the USEPA document in which they are referenced. Due to the confidential business information (CBI) status of much of the MRID-referenced information, the USEPA reports are generally the primary reference for this review.

Each of the toxicity profiles includes information on acute toxicity. As shown in Table 2-1, the USEPA has developed toxicity categories for pesticides based on acute toxicity animal tests conducted in support of registration of the pesticides (USEPA 2003f). Acute toxicity studies are used to determine a number of toxicity endpoints based on a single dose or several large doses of a substance. An important endpoint in acute testing is the toxicity reference level known as the median lethal dose (LD_{50}), which is the dose, usually administered orally, that kills 50% of the test animals. The lower the LD_{50}, the greater the toxicity of the chemical. In addition to the acute oral LD_{50}, the USEPA has a battery of laboratory toxicity studies considered as acute tests (USEPA 2003f) that include acute dermal, acute inhalation (rat), eye irritation (rabbit), dermal irritation (rabbit), and dermal sensitization (guinea pig tests; Table 2-1). For the different toxicity endpoints, the USEPA defines four toxicity categories (I through IV), with higher toxicity categories representing lower acute toxicity.

In longer term toxicity studies (chronic or subchronic) the endpoints for evaluation are the No Observable Adverse Effect Level (NOAEL) and the lowest dose at which an adverse effect has been observed, called a Lowest Observable Adverse Effect Level (LOAEL). Where both levels can be identified in a single study, for a given effect, the LOAEL will always be higher than the NOAEL. In some studies, adverse effects are observed at all dose levels; in these cases, the lowest dose tested (LDT) is identified as the LOAEL. By contrast, where no adverse effects are seen at any dose level tested, the highest dose tested (HDT; also referred to as the limit dose) is identified as the NOAEL.

2.2.2 Dicamba

Dicamba is a benzoic acid herbicide a.i. It can be applied to the leaves or to the soil. Dicamba controls annual and perennial broadleaf weeds in grain crops and grasslands, and it is used to control brush and bracken in pastures. It kills broadleaf weeds before and after they sprout. In combination with a phenoxyalkanoic acid or other herbicide, dicamba is used in pastures, range land, and non-crop areas such as fence-rows and roadways to control weeds. The USEPA has classified this herbicide a.i. as toxicity class III – slightly toxic. Products containing dicamba bear the Signal Word WARNING (Extension Toxicology Network [Extoxnet] 1996c).

2.2.2.1 Acute Toxicity

Table 2-2 lists the toxicity categories for dicamba. In tests in rats, the acute oral LD_{50} was 2,740 milligram per kilogram (mg/kg), placing it in Toxicity Category III. The acute dermal toxicity study in rats showed an LD_{50} greater than 2,000 mg/kg, placing it in Toxicity Category III. The acute inhalation toxicity study in rats showed a median lethal concentration (LC_{50}) greater than 5.3 milligrams per Liter (mg/L), placing it in Toxicity Category IV. The primary eye irritation study in rabbits places dicamba in Toxicity Category II. The primary dermal irritation study categorized dicamba as an irritant, placing it in Toxicity Category II. The primary dermal sensitization study in guinea pigs did not exhibit any sensitization potential (USEPA 2001i).

2.2.2.2 Subchronic Toxicity

In a subchronic neurotoxicity study, Sprague-Dawley rats (10/sex/dose) were fed diets containing dicamba at 0, 3000, 6,000, or 12,000 ppm (0, 197.1, 401.4, 767.9 mg/kg-day for males and 0, 253.4, 472.0, or 1028.9 mg/kg-day for females, respectively) for 13 weeks. Neurobehavioral evaluations, consisting of locomotor activity, and auditory startle response, were conducted at prestudy and during weeks 4, 8, and 13. No toxicologically significant differences were noted in either the mean body weights (BWs) or food consumption of the treated animals. Neurobehavioral evaluations at the 4-, 8-, and 13-week evaluations revealed rigid body tone, slightly impaired righting reflex and impaired gait. At Week 13, the incidences of these findings were decreased. Rigid body tone was also noted during evaluation of the righting reflex and land foot splay. The NOAEL was 401 mg/kg-day and the LOAEL was 768 mg/kg-day based on rigid body tone, slightly impaired righting reflex, and impaired gait (MRID No. 43245210; USEPA 2001i).

2.2.2.3 Chronic Toxicity/Carcinogenicity

In a combined chronic toxicity and carcinogenicity study in rats, dietary administration of dicamba at 0, 50, 250 or 2500 ppm (0, 2.5, 12.5 or 125 mg/kg-day, respectively) for 117 weeks resulted in a dose-related increase in ventricular dilation of the brain in female rats with the incidences at the high dose reaching statistical significance. The incidences were 15/49 (31%), 18/49 (37%), 20/50 (40%) and 30/49 (61%) at 0, 2.5, 12.5, or 125 mg/kg-day, respectively. There was no increased incidence of tumors at any of the doses, suggesting that dicamba is not carcinogenic (MRID No. 000258115; USEPA 2001i).

2.2.2.4 Developmental Toxicity

In a developmental toxicity study, pregnant CD Charles River rats (25/dose group) received gavage administration of dicamba in corn oil at dose levels of 0, 64, 160, or 400 mg/kg-day during gestation days 6 through 19. Maternal toxicity, limited to the high dose (400 mg/kg-day), was characterized by mortality in four pregnant females that exhibited neurotoxic signs prior to death: clinical signs of nervous system toxicity that included ataxia, salivation, stiffening of the body when held, and decreased motor activity; statistically significant decreases in BW gain during the dosing period; and decreases in food consumption. For maternal toxicity, the NOAEL was 160 mg/kg-day and the LOAEL was 400 mg/kg-day based on mortality, clinical signs, BW changes and decreases in food consumption. No treatment-related fetal anomalies were seen at any dose level. For developmental toxicity, the NOAEL was greater than 400 mg/kg-day; a LOAEL was not established (MRID No. 00084024; USEPA 2001i).

In a development toxicity study, inseminated New Zealand White rabbits (19 to 20/dose) were given oral capsules containing dicamba at dose levels of 0, 30, 150, or 300 mg/kg-day from days 6 through 18 of gestation. No maternal toxicity was observed at 30 mg/kg-day. At 150 mg/kg-day, maternal toxicity was characterized by abortion (5%) and clinical signs such as ataxia, and decreased motor activity. At 300 mg/kg-day, maternal toxicity was manifested by abortions, clinical signs, decreased BW and decreased food consumption. For maternal toxicity, the NOAEL was 30 mg/kg-day and the LOAEL was 150 mg/kg-day based on abortions and neurotoxic clinical signs. Development toxicity at 300 mg/kg-day was manifested by irregular ossification of the nasal bones of the skull; no developmental toxicity was seen at 30 or 150 mg/kg-day. For developmental toxicity, the NOAEL was 150 mg/kg-day and the LOAEL was 300 mg/kg-day based on irregular ossification of internasal bones (MRID No. 42429401; USEPA 2001i).

2.2.2.5 Reproductive Toxicity

In a two-generation reproduction study, Sprague-Dawley rats (32 or 28/group) received dicamba in the diet at dose levels of 0, 500, 1,500, or 5,000 ppm (0, 40, 122, or 419 mg/kg-day for males and 0, 45, 136, or 450 mg/kg-day for females, respectively) for two generations. Systemic toxicity was observed at 5,000 ppm, manifested as clinical signs in pregnant females from both generations during lactation (stiff body tone and slow righting reflex) and significantly increased relative liver to BWs in both generations and sexes, adults as well as weanlings. For parental systemic toxicity, the NOAEL was 122 and 136 mg/kg-day for males and females, respectively; and the LOAEL was 419 and 450 mg/kg-day in males and females based on clinical signs of neurotoxicity. Reproductive toxicity at 1,500 and 5000 ppm, manifested as significantly decreased pup growth in all generations and matings at 1,500 ppm and at 5,000 ppm. In addition, delayed sexual maturation was noted in first generation males at 5,000 ppm. For offspring toxicity, the NOAEL was 45 mg/kg-day and the LOAEL was 136 mg/kg-day based on significantly decreased pup growth (MRID No. 43137101; USEPA 2001i).

2.2.2.6 Neurotoxicity

In an acute neurotoxicity study, groups of Crl:CD BR rats (10/sex/dose) received a single oral administration of dicamba in corn oil at doses of 0, 300, 600, or 1,200 mg/kg. At 300 mg/kg, transiently impaired respiration; rigidity upon handling, prodding or dropping; freezing of movement when touched; decreased arousal and fewer rears/minute compared to controls; and impairment of gait and righting reflex were observed in both sexes. In addition, males showed decreased forelimb grip strength. With the exception of the decrease in forelimb grip strength, which persisted until day 7, these effects were observed only on the day of dosing. In addition, at 600 mg/kg, both sexes showed decreases in locomotor activity and males showed significant decreases in tail flick reflex and a raised posture when placed in an open field. At the highest dose level tested (1,200 mg/kg), both males and females showed an impaired startle response to an auditory stimulus. In addition, males showed decreases in BW, BW gain and food consumption. The LOAEL was 300 mg/kg based on the several neurologic signs listed above; a NOAEL was not established (MRID No. 42774104; USEPA 2001i). A subchronic neurotoxicity study is discussed in Section 2.2.2.2.

2.2.2.7 Mutagenicity

Dicamba was negative in tests for mutagenicity (Extoxnet 1996c).

2.2.2.8 Metabolism

Dicamba was excreted rapidly by rats, mainly in the urine, when administered orally or subcutaneously; 1 to 4% was excreted in the feces. Mice, rats, rabbits and dogs excreted 85% of an oral dose as unmetabolized dicamba in the urine within 48 hours of dosing. Eventually, between 90 and 99% of the dose was excreted unmetabolized in the urine. This indicates that dicamba is rapidly absorbed into the bloodstream from the gastrointestinal tract. When dicamba was ingested daily in the feed, the concentrations in different organs reached a steady state within 2 weeks. When daily intake stopped, storage in the organs declined rapidly. Therefore, dicamba does not bioaccumulate in mammalian tissues (Extoxnet 1996c).

2.2.3 Diflufenzopyr

Diflufenzopyr is the first a.i. from a chemical class called semicarbazones. It is registered for use on field corn and grass (USEPA 1999b). In plants, diflufenzopyr acts by inhibiting auxin transport, which causes an abnormal accumulation of auxins in meristematic shoot and root regions, disrupting the delicate auxin balance needed for plant growth (BASF 2001a). The USEPA has completed its review of product chemistry, environmental fate, toxicology, ecological effects, and residue chemistry data, and their summary statement says, "Based on available data, diflufenzopyr has been determined to be of low toxicity to humans, birds, aquatic organisms, mammals and bees. Acute toxicology studies place technical-grade diflufenzopyr in Toxicity Category III (Table 2-2). It is neither teratogenic nor carcinogenic. Additionally, the data indicate no significant risk to non-target organisms, and diflufenzopyr is not expected to pose a risk of groundwater contamination" (USEPA 1999b).

2.2.3.1 Acute Toxicity

Table 2-2 lists the toxicity categories for technical diflufenzopyr. The term 'technical' refers to the commercial product that may contain trace impurities, as opposed to the pure chemical form. The acute oral toxicity(study in rats showed an LD_{50} greater than 5,000 mg/kg in males and females, placing it in Toxicity Category IV. The acute dermal toxicity study in rabbits showed an LD_{50} greater than 5,000 mg/kg in males and females, placing it in Toxicity Category IV. The acute inhalation toxicity study in rats showed an LC_{50} greater than 2.93 mg/L in males and females, which places it in Toxicity Category IV according to USEPA (1999b), although according to the above table, it would be in Toxicity Category III. The primary eye irritation study in rabbits showed mild irritation resolved within 48 hours, placing it in Toxicity Category III. The primary dermal irritation study in rabbits showed no irritation, placing it in Toxicity Category IV. The primary dermal sensitization study in guinea pigs did not exhibit any sensitization potential (USEPA 1999b).

2.2.3.2 Subchronic Toxicity

In a subchronic study in rats, Wistar rats were fed test diets containing technical diflufenzopyr at dose levels of 0, 1,000, 5,000, 10,000 and 20,000 parts per million (ppm) for a period of 13 weeks. The NOAEL was identified as 5,000 ppm (equal to 352 milligrams per kilogram of BW per day (mg/kg-day) for males, and 431 mg/kg-day for females) based on lower mean BW gain and decreased food efficiency in the 10,000 and 20,000 ppm groups for both sexes. Additional findings were decreased food intake and slight changes in blood chemistry (i.e., slight increases in cholesterol and alanine aminotransferase and slight decreases in chloride levels). Histopathological findings included an increased incidence of foamy macrophages in the lungs in the 10,000 and 20,000 ppm groups and testicular atrophy in the 20,000 ppm group. Following the 4-week recovery period, the only treatment-related effects which showed partial or no evidence of recovery were foamy macrophages in the lungs and testicular atrophy (USEPA 1999b).

In a subchronic study in mice, CD-1 mice were dosed with diflufenzopyr at 0, 350, 1,750, 3,500, or 7,000 ppm in the diet for 13 weeks. The NOAEL was determined to be the HDT of 7,000 ppm (1,225 mg/kg-day in males and 1,605 mg/kg-day in females) as no clear toxic effects were observed (USEPA 1999b).

In a subchronic study in dogs, diflufenzopyr was administered to beagle dogs in the diet at dose levels of 0, 1,500, 10,000, or 30,000 ppm for 13 weeks. The LOAEL for this study is 10,000 ppm (403 mg/kg-day in males and 424 mg/kg-day in females), based on the occurrence of erythroid hyperplasia in the bone marrow, extramedullary hemopoiesis in the liver, and hemosiderin deposits in Kupffer cells. The NOAEL is 1,500 ppm (58 mg/kg-day in males and 59 mg/kg-day in females; USEPA 1999b).

In a subchronic dermal toxicity study, technical diflufenzopyr was administered by dermal application to male and female New Zealand White rabbits at dose levels of 0, 100, 300, or 1,000 mg/kg per application. Duration of application was 6 hours a day, daily for 21 to 24 consecutive days. The NOAEL for systemic toxicity was determined to be 1,000 mg/kg-day since there were no apparent signs of treatment-related systemic effects observed in male or female rabbits at any dose level tested. A NOAEL for dermal effects could not be determined since local dermal

irritation was observed at all dose levels (there were no corresponding findings upon histopathological examination, indicating that the dermal effects were all local; USEPA 1999b).

2.2.3.3 Chronic Toxicity/Carcinogenicity

In a chronic toxicity study in dogs, diflufenzopyr was administered to beagle dogs in the diet at dose levels of 0, 750, 7,500 or 15,000 ppm for 52 weeks. The LOAEL for this study is 7,500 ppm (299 mg/kg-day for males and 301 mg/kg-day for females), based on erythroid hyperplasia in the bone marrow in bone sections, reticulocytosis, and increased hemosiderin deposits in the liver, kidneys, and spleen. The NOAEL is 750 ppm (26 mg/kg-day for males and 28 mg/kg-day for females; USEPA 1999b).

In a mouse carcinogenicity study, male and female CD-1 mice were fed test diets containing technical diflufenzopyr at dietary concentrations of 0, 700, 3,500, or 7,000 ppm for a period of 78 weeks. The NOAEL for systemic toxicity was determined to be 7,000 ppm (equal to 1,037 mg/kg-day for males and 1,004 mg/kg-day for females). There were no treatment-related effects observed at any dose level tested in male rats. There was a slight, but statistically significantly lower mean overall BW gain for females in the 7,000 ppm group, primarily due to decreased gain/increased weight loss during the second year of the study. In the absence of any other treatment-related findings, this result was not considered to be an adverse, toxicologically significant finding. There was no evidence of oncogenic potential of diflufenzopyr for male and female mice at any dose level tested (USEPA 1999b).

In a combined chronic toxicity/carcinogenicity study, male and female Wistar rats were fed test diets containing technical diflufenzopyr at dietary concentrations of 0, 500, 1,500, 5,000, or 10,000 ppm for a period of 104 weeks. The NOAEL for systemic toxicity was identified as 5,000 ppm (equal to 236 mg/kg-day for males and 323 mg/kg-day for females). Treatment-related effects in the 10,000 ppm group were significantly lower BW and BW gains throughout the study period and decreased food efficiency. There was no evidence of oncogenic potential of diflufenzopyr at any dose level tested (USEPA 1999b).

2.2.3.4 Developmental Toxicity

In a developmental toxicity study, technical diflufenzopyr was administered by gavage to female Sprague Dawley rats at dose levels of 0, 100, 300, or 1,000 mg/kg-day from days 6 through 15 of gestation. The maternal NOAEL is 300 mg/kg-day and the maternal LOAEL is 1,000 mg/kg-day based on decreases in food consumption and weight gain. Developmental effects, characterized as significantly lower fetal BWs in males and skeletal variations, exhibited as incompletely ossified and unossified sternal centra and reduced fetal ossification sites for caudal vertebrae, were observed at 1,000 mg/kg-day. The developmental LOAEL is 1,000 mg/kg-day, based on decreased fetal BWs and skeletal variations. The developmental NOAEL is 300 mg/kg-day (USEPA 1999b).

In a developmental toxicity study, technical diflufenzopyr was administered by gavage to female New Zealand White rabbits at dose levels of 0, 30, 100, or 300 mg/kg-day from days 6 through 19 of gestation. The maternal LOAEL is 100 mg/kg-day, based on minimal reductions in BW gain with no reduction in food consumption and clinical signs of toxicity (abnormal feces). The maternal NOAEL is 30 mg/kg-day. Developmental effects, characterized as significant increases in the incidence of supernumerary thoracic rib pair ossification sites occurred at the 300 mg/kg-day dose. No treatment-related developmental effects were noted at the low and mid doses. The developmental LOAEL is 300 mg/kg-day based on increased skeletal variations (supernumerary rib ossification sites). The developmental NOAEL is 100 mg/kg-day (USEPA 1999b).

2.2.3.5 Reproductive Toxicity

In a 2-generation reproduction study, technical diflufenzopyr was administered continuously in the diet to Wistar rats at dose levels of 0, 500, 2,000, or 8,000 ppm in the diet. The systemic LOAEL is 2,000 ppm based on reduced BW gain, increased food consumption, and increased seminal vesicle weights. The systemic NOAEL is 500 ppm. The reproductive LOAEL is 8,000 ppm based on lower live birth and viability indices, total pre-perinatal loss, reduced BWs and BW gain during lactation, a higher proportion of runts, and a higher percentage of offspring with no milk in the stomach. The reproductive NOAEL is 2,000 ppm (113-176 mg/kg-day; USEPA 1999b).

2.2.3.6 Neurotoxicity

In an acute neurotoxicity study, diflufenzopyr was administered by gavage to Crl:CD BR rats at dose levels of 0, 125, 500, or 2,000 mg/kg. Diflufenzopyr had no definite impact on neurotoxic responses, although a few abnormalities were observed in the functional battery on the day of dosing. A decrease in immediate righting responses that was observed in several males in all treatment groups was not concentration-dependent. Nasal staining was observed in more rats in the 2,000 mg/kg treatment groups (six males; three females), but was not considered a definite or significant response to treatment. Lower mean brain weights in all female treatment groups lacked associated macroscopic and microscopic histopathological changes, and were only 4 to 5% lower than the control brain weight. Mean locomotor activities for the 2,000 mg/kg female treatment groups were decreased on days 7 and 14 after dosing, but the pattern of activity for the individual animals was similar to the individual controls over time. There were no definite treatment-related differences in BWs or food consumption in any of the treatment groups. There was no evidence of treatment-related neuropathology in the 2,000 mg/kg treatment group. A LOAEL was not established. The NOAEL for acute neurotoxicity is 2,000 mg/kg (the limit dose; USEPA 1999b).

In a subchronic neurotoxicity study, diflufenzopyr was administered in the diet to Crl:CD BR rats at dose levels of 0, 25, 75, or 1,000 mg/kg-day for 13 weeks. No treatment-related neurotoxicological effects were observed at any treatment level. A LOAEL for neurotoxicological effects was not established; the NOAEL was 1,000 mg/kg-day for both sexes. Treatment-related toxic effects (other than neurotoxic effects) were observed at the 1,000 mg/kg-day treatment level. The toxicological LOAEL for this study is 1,000 mg/kg-day, based on decreased BW gains for both sexes. The toxicological NOAEL is 75 mg/kg-day (USEPA 1999b).

2.2.3.7 Mutagenicity

Diflufenzopyr tested negative for mutagenic potential in four assays: a microbial (*Salmonella typhimurium*) mutagenicity assay; an *in vitro* mammalian cell (mouse lymphoma) gene mutation assay; an *in vivo* mouse bone marrow micronucleus assay; and an unscheduled DNA synthesis assay (USEPA 1999b).

2.2.3.8 Metabolism

In a rat metabolism study, radiolabeled diflufenzopyr was administered to Wistar rats as a single intravenous dose at 1 mg/kg-day, a single oral dose (gavage) at 10 or 1,000 mg/kg or a single dose at 10 mg/kg following a 14-day pretreatment with unlabeled diflufenzopyr at 10 mg/kg. Following oral administration, diflufenzopyr was partially absorbed and rapidly eliminated. By oral administration, 20 to 44% of the dose was eliminated in urine and 49 to 79% in feces. By contrast, intravenously dosed rats excreted 61 to 89% of the dose in urine. Biliary elimination accounted for 3 to 19% of the dose in all dose groups. Elimination half-life in urine and feces was 5.2 to 6.9 hours for all single dose groups and 7.7 to 10.8 hours for all repeat oral dose groups. Total radioactive residues in tissues from rats in all dose groups were less than 3% of the administered dose. Blood residue levels for all dose groups were less than 1% of the administered dose at all sampling intervals through 72 hours post-dose. Diflufenzopyr was eliminated in urine, feces, and bile primarily as unchanged parent compound (USEPA 1999b).

A metabolism study of diflufenzopyr was also conducted in laying hens and lactating goats. The data showed diflufenzopyr was rapidly eliminated from the animals. With a feeding level of 10 ppm in the diet, residue levels in edible tissues, milk and eggs were less than 0.12 ppm. The metabolite profile in rat was similar in hen and goat (USEPA 1999b). These studies show that diflufenzopyr is rapidly eliminated as unchanged parent compound.

2.2.4 Diquat

Diquat dibromide is a non-selective contact herbicide a.i., algicide, dessicant, and defoliant. As an herbicide/algicide it is used to control broadleaf and grassy weeds in non-crop and aquatic areas. As a dessicant/defoliant it is used in seed crops and potatoes (USEPA 1995). Diquat dibromide is rapidly absorbed into the leaves of plants, but usually kills the plant tissues necessary for translocation too quickly to allow movement to other parts of the plant. It does not kill roots, but it does kill the leaves and stems it contacts. It produces rapid results by interfering with photosynthesis.

However, the sudden addition of decaying plant biomass to the water column can result in decreased oxygen levels (New York State Deparment of Environmental Conservation (NYSDEC; 1981 *cited in* McLaren/Hart 1995; Extoxnet 1996a).

2.2.4.1 Acute Toxicity

Table 2-2 lists the toxicity categories for diquat dibromide. Diquat dibromide is not acutely toxic via the oral (Toxicity Category III) and inhalation (Toxicity Category III) routes of exposure. Diquat dibromide is moderately to severely toxic via the dermal route of exposure, as evidenced by the acute dermal toxicity study (Toxicity Category II). However, diquat dibromide was not found to be a dermal irritant (Toxicity Category IV) or a dermal sensitizer. Diquat dibromide is toxic to the eye, as evidenced by the eye irritation study, which showed slight to severe eye irritation following acute exposure (Toxicity Category II; USEPA 2001e).

2.2.4.2 Subchronic Toxicity

In a subchronic dermal toxicity study (MRID No. 40308101), Sprague-Dawley rats were exposed to technical diquat dibromide by dermal application at dose levels of 0, 5, 20, 40, or 80 mg/kg-day (as diquat cation). Duration of application was 6 hours a day, for 21 consecutive days. High mortality was observed in the 40 mg/kg (67%) and 80 mg/kg (90%) groups. Effects in the nonsurvivors included hypothermia, hypoactivity, dyspnea, cyanosis, pale extremities, and emaciated appearance. The LOAEL for systemic toxicity was determined to be 20 mg/kg-day, based on effects including sores, severe erythema, fissures, acute necrotizing purulent dermatitis, and degeneration of hair follicles and sebaceous glands, all at the application site. The NOAEL for systemic toxicity was 5 mg/kg-day, based on mortality and clinical signs at 20 mg/kg-day (LOAEL). Dermal irritation and tissue destruction occurred at the application site at all dose levels (USEPA 2001e).

In a subchronic inhalation toxicity study (MRID No. 40301701), Fischer 344 rats were exposed to respirable aerosols of technical diquat at concentrations of 0, 0.49, 1.1, or 3.8 micrograms per liter (μg/L; as diquat cation). Exposure duration was 6 hours a day, 5 days per week, for 21 days. Test animals, which were exposed whole body, and control animals were rinsed with tap water and blotted dry after each exposure to minimize oral exposure from grooming. Treatment-related effects observed at the lowest concentration tested included significant increases in mean lung weight, mottling and reddening of the lungs, and lung lesions. The NOAEL is 0.1 μg/L (males 0.024 mg/kg-day; females 0.026 mg/kg-day), based on increased lung weights and microscopic lesions in the lungs at the LOAEL of 0.49 μg/L (males 0.117 mg/kg-day, females 0.128 mg/kg-day; USEPA 2001e).

2.2.4.3 Chronic Toxicity/Carcinogenicity

In a chronic toxicity study in dogs (MRID No. 41730301), technical diquat dibromide was administered to beagle dogs in the diet at dose levels of 0, 0.5, 2.5, or 12.5 mg/kg-day (as diquat cation) for 52 weeks. No treatment-related effects were detected at any dose level in terms of survival, clinical signs, hematology, clinical chemistry, urinalysis, and gross pathology (except eye). Decreased BW gains were observed only during the first 2 weeks of dosing in both sexes at the high-dose level. At necropsy, bilateral lens opacity was observed in all high-dose males and three-fourths of the high-dose females. The NOAEL is 0.5 mg/kg-day, based on unilateral cataracts in females and decreased weight of the epididymides in males at the systemic LOAEL of 2.5 mg/kg-day (USEPA 2001e).

In a combined chronic toxicity/carcinogenicity study (MRID No. 00145855), male and female Sprague-Dawley rats were fed diets containing diquat cation at dietary concentrations of 0, 5, 15, 75, or 375 ppm for 104 weeks. Treatment-related effects observed in the 75 ppm group were lens opacity, marked or severe cataracts, and extralenticular lesions (adhesions, retinal detachment and synechia). Therefore, the systemic LOAEL is 75 ppm (equal to 2.91 mg/kg-day for males; 3.64 mg/kg-day for females) and the NOAEL for systemic toxicity was set at 15 ppm (equal to 0.58 mg/kg-day for males; 0.72 mg/kg-day for females). There was no treatment-related increase in tumor incidence in either sex (USEPA 2001e).

In a mouse carcinogenicity study (MRID No. 42219801), male and female CD-1 mice were fed diets containing technical diquat dibromide at dietary concentrations of 0, 30, 100, or 300 ppm (as diquat cation) for 104 weeks (2

years). Treatment-related effects observed in the 100 ppm group included eye discharge, decreased weight gain, increased kidney weight, tubular dilatation of the kidneys, tubular hyaline droplet formation in the kidneys, and lymphoid proliferation. Therefore the systemic LOAEL is 100 ppm (equal to 11.96 mg/kg-day for males; 16.03 mg/kg-day for females). The NOAEL for systemic toxicity was determined to be 30 ppm (equal to 3.56 mg/kg-day for males; 4.78 mg/kg-day for females). Diquat dibromide was not carcinogenic in male or female CD-1 mice (USEPA 2001e).

The database for carcinogenicity is considered complete. The carcinogenic potential of diquat dibromide was classified as Category E (evidence of noncarcinogenicity for humans) based on a lack of evidence of carcinogenicity in studies with two species, rat and mouse (USEPA 2001e).

2.2.4.4 Developmental Toxicity

In a developmental toxicity study (MRID No. 41198902), diquat dibromide was administered by gavage to female Wistar rats at dose levels of 0, 4, 12, or 40 mg/kg-day (as diquat cation) on days 7 through 16 of gestation. The LDT of 4 mg/kg-day was associated with decreased maternal weight gain and food consumption. The maternal LOAEL is <4 mg/kg-day and the NOAEL for maternal toxicity is not established. Developmental effects, characterized as significantly lower fetal BWs, increased incidence of a hemorrhagic kidney, and skeletal variations exhibited as incompletely ossified and unossified sternal centra and reduced fetal ossification sites for caudal vertebrae, were observed at 40 mg/kg-day, the HDT. The developmental LOAEL is 40 mg/kg-day, based on decreased fetal BWs and skeletal variations. The developmental NOAEL is 12 mg/kg-day (USEPA 2001e).

In another developmental toxicity study (MRID No. 41198901), diquat dibromide was administered by gavage to female New Zealand White rabbits at dose levels of 0, 1, 3, or 10 mg/kg-day (as diquat cation) on days 7 through 19 of gestation. The maternal LOAEL is 3 mg/kg-day, based on decreased maternal weight gain and food consumption. The maternal NOAEL is 1 mg/kg-day. Developmental effects occurred only in the high dose group, characterized as increases in the incidence of friable livers, mottled livers, partially ossified ventral tubercle of cervical vertebrae, and partially ossified and unossified sternebra. The developmental LOAEL is 10 mg/kg-day (the HDT), and the developmental NOAEL is 3 mg/kg-day (USEPA 2001e).

In a third developmental toxicity study (MRID No. 00061637), diquat dibromide was administered by gavage to female Alderley Park strain SPF albino mice at dose levels of 0, 1, 2, and 4 mg/kg-day (as diquat cation) on days 6 through 15 of gestation. The maternal LOAEL is 2 mg/kg-day, based on effects including a decreased maternal weight gain, piloerection, dyspnea, respiratory noise, and abnormal posture. The maternal NOAEL is 1 mg/kg-day. Developmental effects occurred only in the high dose group, characterized as decreased fetal BW and increases in the incidence of skeletal alterations. The developmental LOAEL is 4 mg/kg-day (the HDT), and the developmental NOAEL is 2 mg/kg-day (USEPA 2001e).

2.2.4.5 Reproductive Toxicity

In a 2-generation reproduction study (MRID No. 41531301), diquat dibromide was administered continuously in the diet to Wistar rats at dose levels of 0, 16, 80, or 400/240 ppm (as diquat cation). Because adverse effects were seen in the F1 animals (i.e., the first generation animals), the high dose for the F0 animals (i.e., the parents) was reduced from 400 ppm to 240 ppm 4 weeks after selection. There were no treatment-related deaths. Parental toxicity was observed in both generations, mostly at the high-dose level, as increased incidences of clinical signs, ophthalmoscopic signs, decreased body-weight gains and decrease food consumption during the premating period. Ophthalmoscopic examination revealed partial/total cataracts at the high-dose level in both sexes and both generations following the premating dosing periods. At the high-dose level in both generations and both sexes, the incidence of partial and/or total cataract increased with time.

The systemic LOAEL is 4 mg/kg-day (80 ppm) based on decreased BW gain, decreased food consumption, and increased incidences of eye opacity, lenticular cataracts, and iritis. The systemic NOAEL is 0.8 mg/kg-day (16 ppm). The reproductive LOAEL is 400/240 ppm (20/12 mg/kg-day), based on a decreased number of live pups per litter and decreased pup BW gain. The reproductive NOAEL is 4 mg/kg-day (80 ppm; USEPA 2001e).

2.2.4.6 Neurotoxicity

In an acute neurotoxicity study (MRID No. 42666801), technical diquat dibromide was administered by gavage to Sprague-Dawley rats at dose levels of 0, 25, 75, or 150 mg/kg (as diquat cation). Diquat dibromide had no definite impact on neurotoxic responses in functional observational battery and motor activity measurements at 6 hours after dosing and on days 8 and 15. Clinical evidence of neurotoxicity included increased incidence of diarrhea and nasal staining in females in the 75 mg/kg group. Females in the 150 mg/kg group showed additional effects of piloerection, upward curvature of the spine, hunched posture, and tip toe gait. The systemic NOAEL is 75 mg/kg, based on clinical signs and decreased body-weight gain at the systemic LOAEL of 150 mg/kg (USEPA 2001e).

In a subchronic neurotoxicity study (MRID No. 42616101), technical diquat dibromide was administered in the diet to Alpk:APfSD rats at dose levels of 0, 20, 100, or 400 ppm for 13 weeks. Treatment-related toxic effects observed in the 400 ppm group included decreased BWs, decreased BW gain, decreased food utilization, incidence of total cataracts, and posterior opacities of the lens. There was no evidence of neurotoxicity. The NOAEL for neurotoxicity is 400 ppm (32.4 mg/kg-day for males, 38.5 mg/kg-day for females), the HDT. The systemic NOAEL is 100 ppm (8.0 mg/kg-day for males, 9.5 mg/kg-day for females), based on cataracts, decreased body-weight gain and food utilization at the systemic LOAEL for this study of 400 ppm (32.4 mg/kg-day for males, 38.5 mg/kg-day for females; USEPA 2001e).

2.2.4.7 Mutagenicity

Diquat dibromide was found to be negative for mutagenic potential in several assays. These included microbial gene mutation assays (Ames assays using five strains of *Salmonella typhimurium* and one strain of *Escherichia coli*; MRID No. 40323103), two structural chromosome aberration tests, an *in vivo* mouse bone marrow micronucleus assay (MRID No. 40323104), an *in vivo* dominant lethal assay in mice (MRID No. 00061636), and assays of other genotoxic effects (e.g., unscheduled DNA synthesis in rat hepatocytes *in vitro*; MRID No. 40323107).

Diquat dibromide was positive in one gene mutation test (*in vitro* mouse lymphoma cell assay; MRID No. 40323101), in one chromosome aberration test (*in vitro* human blood lymphocytes from one male and one female donor; MRID No. 40323106; USEPA 1995), and in an *in vitro* genotoxicity assay. However, the response was generally weak and was observed at cytotoxic levels (levels that are toxic to the cell; USEPA 2001e).

2.2.4.8 Metabolism

In a rat metabolism study (MRID No. 0055107), [^{14}C]-labeled diquat dibromide was administered to rats. Ninety percent of the orally administered dose was eliminated in feces indicating poor gastrointestinal absorption. In addition, rats injected subcutaneously with [^{14}C]-diquat dibromide excreted nearly all of the labeled material in the urine within 2 days (USEPA 2001e).

Following a single oral dose of 60 mg/kg (in the form of the diquat cation) of [^{14}C]-diquat dibromide, only 5% of the radioactivity was recovered in the urine within 7 days (MRID No. 00065592). Whole body autoradiography indicated that diquat dibromide was initially concentrated in the cartilaginous tissues, liver, and bladder. After 24 hours, the only radioactivity detected was in the bladder and intestines. Feeding 250 mg/kg (as the diquat cation) of unlabeled diquat dibromide to rats for 2, 4, or 8 weeks resulted in no accumulation of diquat dibromide in tissues including brain, liver, lung, stomach, small and large intestines, muscle, and blood. The kidneys retained 0.18 to 1.17 ppm of diquat dibromide for 2 to 8 weeks (USEPA 1995).

Labeled [^{14}C]-diquat dibromide was administered to rats by stomach tube or by subcutaneous injection (doses not specified) for four days (MRID No. 00065593). The rats excreted 6.3% of the orally administered diquat dibromide in urine and 89.3% in feces within 4 days, most during the first 48 hours (5.3% was unmetabolized diquat and 1% was diquat monopyridone, diquat dipyridone, and unidentified metabolites). Of the radioactivity in the sulfuric acid-extractable fraction (65.5%), 57.1% was unmetabolized diquat, 4.3% was diquat monopyridone, and 4.1% represented unidentified metabolites. Following subcutaneous administration, 87.1% of the dose was recovered in the

urine within four days (5% within 24 hours), and 78.8% of the radioactivity was unmetabolized diquat. The amounts of other metabolites were not reported (USEPA 1995).

2.2.5 Fluridone

Fluridone is a systemic herbicide a.i. used to manage aquatic vegetation on ponds, lakes, reservoirs, canals, and rivers. Fluridone is absorbed from the water by the shoots of submerged plants and from the hydrosoil by the roots of aquatic vascular plants. It acts by inhibiting the synthesis of carotenoid pigments that protect chlorophyll from photodegradation. In the absence of the colored carotenoid beta-carotene, chlorophyll is destroyed and chloroplasts are disrupted in the sunlight, causing cellular bleeding. Affected plants become white or chlorotic at growing points and slowly die (Bartels and Watson 1978 *cited in* McLaren/Hart 1995; USEPA 1986).

2.2.5.1 Acute Toxicity

Table 2-2 lists the toxicity categories for fluridone (technical). The USEPA (1986) reported that technical grade fluridone is in Toxicity Category IV (very slight) for acute oral exposure in the rat. This is supported by oral LD_{50} values of more than 10,000 mg/kg for both the rat and the mouse (Elanco 1981 *cited in* McLaren/Hart 1995; SePRO 2002).

A dermal LD_{50} of greater than 500 mg/kg with no skin irritation was originally reported for rabbits exposed to technical fluridone (USEPA 1986), but an LD_{50} value of greater than 2,000 mg/kg was later reported (USEPA 1988 *cited in* Massachusetts Department of Environmental Management and Massachusetts Department of Environmental Protection [MA DEM/MA DEP] 2003). SePRO (2002) cites an LD_0 of more than 5,000 mg/kg with no signs of systemic toxicity for the rabbit. The more recently reported values place fluridone in Category III (slight) for acute dermal effects.

The USEPA reported that fluridone is moderately toxic through acute inhalation exposure, equivalent to Toxicity Category II (USEPA 1986). However, LC_{50} values for rats exposed to technical fluridone at concentrations of 2.13 mg/L (1 hour exposure) and 4.12 mg/L (4 hour exposure; USEPA 1986, SePRO 2002), indicate that fluridone is in Category III (slight) for acute inhalation effects.

Eye irritation has been demonstrated as moderate to severe in rabbits with effects including redness, corneal dullness, and conjunctivitis, placing fluridone in Category II (USEPA 1986; USEPA 1988 *cited in* MA DEM/MA DEP 2003). However, the manufacturer states that ocular irritation was not persistent and resulted primarily from the abrasive nature of the technical material, therefore fluridone should be in Category IV (slight) for eye irritation effects (SePRO 2002). Fluridone was found to be neither irritating nor a sensitizer to rabbit skin at 2,000 mg/kg (USEPA 1988 *cited in* MA DEM/MA DEP 2003), thus placing fluridone in Category IV for primary skin irritation, and designating fluridone as not a skin sensitizer.

2.2.5.2 Subchronic Toxicity

In a subchronic feeding study, rats were fed a test diet containing technical fluridone at a range of dose levels including 0, 330, and 1,400 ppm for a period of 90 days (MRID No. 00135208; USEPA 1986; USEPA 1988 *cited in* MA DEM/MA DEP 2003). Effects observed at the 1,400 ppm level included increased liver and kidney weights as well as histological identification of liver centrilobular hypertrophy (USEPA 1986). A NOAEL of 30 mg/kg-day is reported in USEPA (1988 *cited in* MA DEM/MA DEP 2003), based on increased liver weights at the 166 mg/kg-day level and no treatment-related effects at the 330 ppm level. A NOAEL of 53 mg/kg-day is cited in McLaren/Hart (1995) and referenced to New York State Deparment of Health (NYSDOH; 1986), but no information on the derivation of the NOAEL is provided. The USEPA (2002a) does not cite a NOAEL for this study, but reports a LOAEL of 166 mg/kg-day based on increased liver weights at the LDT.

In a subchronic feeding study, mice were dosed with fluridone at a range of levels including 0, 62, and 560 ppm in the diet for 90 days (USEPA 1986, USEPA 1988 *cited in* MA DEM/MA DEP 2003). Effects observed at the 560 ppm level included histological identification of liver centrilobular hypertrophy (USEPA 1986). Morphological changes in

the liver and an increase in absolute liver weight in males at a fluridone concentration of 0.033% are reported in USEPA (1988 *cited in* MA DEM/MA DEP 2003). Partial enlargement of livers was observed at the 16.5 mg/kg-day level and no treatment-related effects at the 62 ppm level (USEPA 1988 *cited in* MA DEM/MA DEP 2003). A NOAEL of 9.3 mg/kg-day is cited in McLaren/Hart (1995) and referenced to NYSDOH (1986), but no information on the derivation of the NOAEL is provided. The USEPA (2002a) does not cite this study.

In a subchronic feeding study in dogs, fluridone was administered in the diet at a range of dose levels up to 200 mg/kg-day for 90 days (MRID No. 0082234). A NOAEL of 200 mg/kg-day is based on the observation of no treatment-related effects at the HDT (Elanco 1978a *cited in* USEPA 2002a).

In a subchronic dermal toxicity study, fluridone was applied to rabbit skin at doses including 0, 192, 384, and 768 mg/kg-day for 21 days (MRID No. 00070933). An increase in organ weight was noted at 384 mg/kg-day. The NOAEL for systemic effects was determined to be the HDT of 768 mg/kg-day, since no systemic effects were noted at any dose. A NOAEL for dermal effects was not determined since dose-dependent skin irritation was observed at all doses (USEPA 1988 *cited in* MA DEM/MA DEP 2003; SePRO 2002.

2.2.5.3 Chronic Toxicity/Carcinogenicity

In a combined chronic toxicity/carcinogenicity study in rats, male and female Fischer rats were fed test diets containing technical fluridone at dietary concentrations of 0, 200, 650, or 2,000 ppm (0, 8, 25, or 81 mg/kg-day) for a period of 104 weeks (MRID Nos. 00103251, 00103305). Treatment-related effects observed at 650 ppm included glomerulonephritis, atrophic testes, eye keratitis, and decreased BW and organ weights. The NOAEL for systemic toxicity was set at 200 ppm (equal to 8 mg/kg-day). There was no evidence of oncogenic potential of fluridone at any dose levels tested (USEPA 2002a).

In a combined chronic toxicity/carcinogenicity study in mice, mice were administered fluridone concentrations in the diet including 0, 100, and 330 ppm for 104 weeks (MRID Nos. 00103252, 00103305). According to USEPA (1988), as cited in MA DEM/MA DEP (2003), there was a dose-dependent increase in alkaline phosphatase in males exposed at the HDT of 330 ppm. No other toxic effects or lesions are reported at any other doses. The clinical NOAEL is equal to the HDT as evidenced by no deaths, no obvious toxic effects, and no histopathological lesions. McLaren/Hart (1995) reports a NOAEL for systemic toxicity of 11.6 mg/kg-day from this study (NYSDOH 1986). A NOAEL of 15 mg/kg-day (equal to 100 ppm) is reported by USEPA (2002a). There was no evidence of oncogenic potential of fluridone at any of the dose levels tested.

In a 1-year chronic feeding study in which dogs were administered fluridone by capsule in food, several effects including weight loss, increased liver weight and increased levels of alkaline phosphatase were reported at a dose level of 150 mg/kg-day (MRID No. 00103336); a NOAEL of 75 mg/kg-day was extrapolated from this study (USEPA 1988 *cited in* MA DEM/MA DEP 2003; USEPA 2002a).

2.2.5.4 Developmental Toxicity

In an initial developmental toxicity study in which rats were exposed to up to 200 mg/kg-day of fluridone, no developmental effects were observed at any of the levels tested. However, the study was not useful for regulatory purposes because no maternal toxicity or fetotoxicity was seen at the HDT (200 mg/kg-day); therefore, the USEPA requested that a second study be conducted (USEPA 1986).

In a subsequent rat developmental toxicity study, rats (second species) were administered fluridone by oral gavage in doses of 0, 100, 300, or 1,000 mg/kg-day (MRID No. 00159963). At 300 mg/kg-day there was a decrease in maternal BW, and a maternal NOAEL of 100 mg/kg-day was established. At 1,000 mg/kg-day fetal weight loss and delayed ossification were noted; therefore the NOAEL for developmental effects was established at 300 mg/kg-day. Teratogenic effects (skeletal abnormalities in the fetus) were not observed in any dose group, so a teratogenic NOAEL of 1,000 mg/kg-day was established at the HDT (USEPA 1988 *cited in* MA DEM/MA DEP 2003; USEPA 2002a).

In a pilot developmental toxicity study, rabbits were exposed to fluridone doses of 0, 250, 500, 750, or 1,000 mg/kg-day. A maternal NOAEL of 500 mg/kg-day (based on effects on the mother) was identified resulting from maternal weight loss at the 750 mg/kg-day dose level. Fetal resorptions occurred in the 500 mg/kg-day dose group, and consequently the developmental NOAEL (based on effects on the offspring) in this study was set at 250 mg/kg-day (USEPA 1988 *cited in* MA DEM/MA DEP 2003).

In a separate developmental toxicity study, rabbits were exposed to 0, 125, 300, or 750 mg/kg-day of fluridone during gestation (MRID No. 00103302 per USEPA 2002a; MRID No. 00263157 per USEPA 2003a). Effects including maternal weight loss and abortion were noted at the 300 mg/kg-day dose level. Therefore, the maternal NOAEL for this study was set at 125 mg/kg-day. Teratogenic effects were not observed at any dose, so the NOAEL for teratogenic effects is the HDT, or 750 mg/kg-day (USEPA 1988 *cited in* MA DEM/MA DEP 2003; USEPA 2002a).

2.2.5.5 Reproductive Toxicity

In a 3-generation reproduction study, technical fluridone was administered continuously in the diet to rats at dose levels of 0, 650, and 2,000 ppm (MRID No. 00103304). Since no maternal or teratogenic effects were observed at the HDT of 2,000 ppm, and the maternal and teratogenic NOAEL is 2,000 ppm (100 mg/kg-day). The developmental NOAEL is 650 ppm (32.5 mg/kg-day), based on decreased pup weight reported at the 100 mg/kg-day level (USEPA 2002a).

2.2.5.6 Neurotoxicity

Studies of fluridone neurotoxicity were not identified. No clinical signs of neurotoxicity or neuropathology were reported in any of the chronic or reproductive toxicity studies conducted.

2.2.5.7 Mutagenicity

Mutagenicity assays submitted for fluridone do not indicate potential for genotoxicity, gene mutation, or structural chromosomal aberration (USEPA 1986). Fluridone was found to be negative for mutagenic potential in four assays: fluridone did not induce bacterial mutations in the Ames assay at the highest tested concentration of 1,000 ppm; a fluridone intraperitoneal dose of 500 mg/kg did not induce sister chromatid exchange in Chinese hamster bone marrow cells; fluridone did not promote unscheduled DNA synthesis in rat hepatocytes when tested at a concentration of 300 ppm; and a single oral dose of 2,000 mg/kg did not cause dominant lethal mutations in male rats (USEPA 1988 *cited in* MA DEM/MA DEP 2003; SePRO 2002).

2.2.5.8 Metabolism

The residue of concern in drinking water is the parent compound fluridone (USEPA 1986). The primary metabolite of fluridone in fish is Metabolite II, 1-methyl-3-(4-hydroxyphenyl)-5-[3-(trifluoromethyl)phenyl]-4(1H)-pyridinone. 1,4-dihydro-1-methyl-4-oxo-5-[3-(trifluoromethyl)phenyl]-3-pyridinone was identified as the major metabolite in laboratory hydrosoil studies. N-methyl formamide (NMF) was identified as a photolytic breakdown product in a laboratory study *cited in* McLaren/Hart (1995). Scientists were concerned with NMF being produced by the breakdown of fluridone since NMF has been shown to be teratogenic in rabbits at high doses and can penetrate human skin; however, NMF has not been identified in the natural environment (McLaren/Hart 1995).

Absorption/excretion studies in rats indicate that a single oral dose of fluridone is rapidly absorbed, extensively metabolized and primarily excreted in the feces. The dose was excreted in 72 hours. More than 80% was excreted in the feces and a trace was excreted in the urine (Arnold 1979 *cited in* McLaren/Hart 1995).

2.2.6 Imazapic

Imazapic is a member of the imidazolinone class of herbicides that selectively inhibit acetohydroxyacid synthetase, an enzyme in certain plant's biosynthetic pathway of three amino acids—valine, leucine, and isoleucine. In contrast to

plants, mammals do not possess the pathway to synthesize these three amino acids, and therefore are not susceptible to the primary effect pathway of imazapic (USEPA 2001a).

2.2.6.1 Acute Toxicity

Table 2-2 lists the toxicity categories for imazapic. Imazapic results in low acute toxicity by oral, dermal, and inhalation routes of exposure, as well as eye and skin irritation (all studies are in Toxicity Category III or IV). Imazapic is not a dermal sensitizer (USEPA 2001a).

2.2.6.2 Subchronic Toxicity

A 21-day dermal toxicity study in rabbits was conducted (MRID No. 42711420) where imazapic was applied to the clipped backs of New Zealand albino rabbits at targeted doses of 0, 250, 500, or 1,000 mg/kg-day for 6 hours per day, 5 days per week, for 3 weeks. There were no systemic or developmental effects observed up to the HDT (1,000 mg/kg-day), therefore a toxicity endpoint was not selected from this study (USEPA 2001a).

2.2.6.3 Chronic Toxicity/Carcinogenicity

In a 24-month combined chronic feeding/carcinogenicity study (MRID No. 43320307), imazapic was administered in the diet to groups of 65 male and 65 female Sprague-Dawley strain rats at doses of 0, 5,000, 10,000 or 20,000 ppm. At the highest dose level tested (20,000 ppm), no treatment-related effects were observed. Also, no treatment-related increase in tumors of any kind was observed at any dose level. The NOAEL in this study for both male and female rats is the HDT, 20,000 ppm (1,029 mg/kg-day for males and 1,237 mg/kg-day for females). A LOAEL was not determined.

In an 18-month chronic feeding/carcinogenicity study (MRID No. 43320306), imazapic was administered in the diet to groups of 65 male and 65 female CD-1 strain mice at dose levels of 0, 1,750, 3,500 or 7,000 ppm. At the highest dose level tested (7,000 ppm, the HDT), no treatment-related effects were observed in either male or female mice. Statistically significant decreases in high- and mid-dose male BWs during the first 26 weeks of the study were not convincing indicators of toxicity because the decreases were small, were noted even before initiation of treatment, and were not dose-related. No treatment-related increase in tumors of any kind was observed in either male or female mice at any dose level. The NOAEL in this study for both male and female mice is 7,000 ppm (1,134 mg/kg-day for males and 1,442 mg/kg-day for females). A LOAEL was not determined (USEPA 2001a).

2.2.6.4 Developmental Toxicity

In a developmental toxicity study (MRID No. 42711422), groups of 25 impregnated Sprague-Dawley rats were administered imazapic via gavage at daily doses of 0, 250, 500 or 1,000 mg/kg-day on gestational days 6 through 15. There were no treatment-related effects on mortality, abortions, clinical signs, BW, BW gain, food consumption, or Caesarean section parameters at any of the doses, including 1,000 mg/kg-day. Therefore, the maternal NOAEL is 1,000 mg/kg-day, and the maternal LOAEL is greater than 1,000 mg/kg-day. There were no treatment-related effects on resorptions, pre- and post-implantation losses, fetal BW and sex ratio, or external, visceral, and skeletal malformations and anomalies. Therefore, the developmental NOAEL is 1,000 mg/kg-day, and the developmental LOAEL is greater than 1,000 mg/kg-day.

In a developmental toxicity study (MRID No. 42711423), groups of 20 impregnated New Zealand White rabbits were administered imazapic via gavage during gestation days 7 through 19 at daily doses of 0, 175, 350, 500, or 700 mg/kg-day. The occurrence of only 7 litters at 700 mg/kg-day precluded a meaningful evaluation of developmental findings at this dose, therefore this dose was not considered further in the study. The LOAEL for maternal toxicity is 500 mg/kg-day based on decreased BW gain and food consumption during the dosing period. The NOAEL for maternal toxicity is 350 mg/kg-day. Although there was an increase in fetal incidences of rudimentary ribs, the study authors concluded that these effects are not related to the treatment. Therefore, the NOAEL for developmental toxicity was set at 500 mg/kg-day, and the LOAEL for developmental toxicity is greater than 500 mg/kg-day (USEPA 2001a).

2.2.6.5 Reproductive Toxicity

In a 2-generation rat reproduction study (MRID No. 43320305), imazapic was administered by diet to 2 groups of 30 per sex Sprague-Dawley rats at levels of 0, 5,000, 10,000, or 20,000 ppm. There were no compound-related effects in any parameter evaluated in either male or female parental animals or offspring of the first or second generation. Therefore, the parental, reproductive, and offspring NOAELs are 20,000 ppm, and the LOAELs are greater than 20,000 ppm (USEPA 2001a).

2.2.6.6 Neurotoxicity

There are no neurotoxicity studies in rats or hens (which are a common test species for neurotoxic effects), and there were no neurotoxic clinical signs or histopathology observed in any of the other toxicity studies with imazapic (USEPA 2001a).

2.2.6.7 Mutagenicity

Imazapic was found to be negative in the following mutation assays: a reverse gene mutation assay using *Salmonella* strains (MRID No. 42711424); a chromosome aberration assay in Chinese hamster ovary cells (MRID No. 42711427); a forward mutation assay in Chinese hamster ovary cells (MRID No. 42711425); and a rat bone marrow/chromosomal aberration assay (MRID No. 42711426; USEPA 2001a).

2.2.6.8 Metabolism

A rat metabolism study demonstrated that only the unchanged parent compound was detected in the urine, which was the major route of excretion. These results indicated that imazapic was not metabolized to other compounds. There was no evidence of bioaccumulation of imazapic in tissues (USEPA 2001a).

2.2.7 Sulfometuron Methyl

Sulfometuron methyl is a non-selective, sulfonyl urea herbicide a.i. used mainly to control the growth of broadleaf weeds and grasses. The mode of action for the sulfonyl urea class is the inhibition of the synthesis of essential amino acids (SERA 1998).

2.2.7.1 Acute Toxicity

The USEPA has not developed acute toxicity categories for sulfometuron methyl (USEPA 2003b). Acute oral exposure to sulfometuron methyl results in a low order of toxicity. Neither mortality nor overt signs of toxicity were observed in rats given single oral doses of up to 17,000 mg/kg (Trivits 1979 *cited in* SERA 1998; Dashiell and Hall 1980; Dashiell and Hinckle 1980; Filliben 1995). The acute dermal toxicity of the compound is also low. The LD_{50} values for exposure through the skin ranges from over 2,000 mg/kg in female rabbits to over 8,000 mg/kg in male rabbits (USEPA 1990 *cited in* Extoxnet 1996b). The technical compound, is not a skin irritant or skin sensitizer (USEPA 1990 *cited in* Extoxnet 1996b), but it has mild eye irritant properties in rabbits (Fletcher et al. 1993 *cited in* Extoxnet 1996b). The acute inhalation LC_{50} is above 5.3 mg/L in rats, indicating its slightly toxic nature by this route (Weed Science Society of America 1994 *cited in* Extoxnet 1996b).

2.2.7.2 Subchronic Toxicity

The most common signs of toxicity from sulfometuron methyl involve hemolytic anemia and decreased BW gain (SERA 1998). In one subchronic study, 3,400 mg/kg-day sulfometuron methyl was administered to six rats for 14 days (Hinckle 1979 *cited in* SERA 1998), and the investigators observed reduced testicular size in one rat and mild testicular lesions in another. No such effects were observed in any of the six control rats.

2.2.7.3 Chronic Toxicity/Carcinogenicity

Several toxic effects have been noted with chronic exposure to sulfometuron methyl in test animals. At doses of 25 mg/kg-day, dogs experienced reduced red blood cell counts and increased liver weight (Wood and O'Neal 1983 *cited in* Extoxnet 1996b). In this study, dogs were fed the compound in their food for a year. In a 2-year feeding study on rats, no effects were noted below 7.5 mg/kg-day (USEPA 1990 *cited in* Extoxnet 1996b).

In chronic bioassays conducted in mice (Summers 1990 as cited in SERA 1998) and rats (Mullin 1984 as cited in SERA 1998), toxicity was indicated by hematological changes in the high dose groups of both studies. Carcinogenicity was not demonstrated in either study (SERA 1998).

2.2.7.4 Developmental Toxicity

Two teratogenicity studies were conducted in which rabbits were exposed to sulfometuron methyl by gavage. The study by Hoberman et al. (1981 *cited in* SERA 1998) involved relatively high dose levels (100 to 1,000 mg/kg BW), while the study by Serota et al. (1981 *cited in* SERA 1998) involved dose levels of 30 to 300 mg/kg BW). In the Hoberman et al. (1981) study, signs of maternal toxicity, including death in some female parents, were apparent at all dose levels. Possible spontaneous abortions were noted at doses of 300 mg/kg or greater. In the lower dose study by Serota et al. (1981), there were no signs of toxicity in the dams or offspring. Nonetheless, the investigators observed an increased number of fetuses with anomalies as well as an increase in the proportion of fetal anomalies per litter, compared with controls (SERA 1998).

2.2.7.5 Reproductive Toxicity

There are three reproduction studies involving dietary exposure of rats to sulfometuron methyl (Wood et al. 1980; Lu 1981; Mullin 1984 *cited in* SERA 1998). Decreases in maternal BW gain associated with decreased food consumption and hematological changes were the most common effects observed in these studies. Dietary levels of 5,000 ppm were associated with changes in developmental parameters, including decreased fetal weight (Lu 1981) and a decreased number of pups in the F1 and F2 generations (Mullin 1984). In addition to these effects, mean absolute brain weights decreased significantly in male rats (Mullin 1984).

2.2.7.6 Neurotoxicity

Specific neurotoxicity studies are not available in the database (SERA 1998).

2.2.7.7 Mutagenicity

Sulfometuron methyl did not show mutagenic activity in assays of *Salmonella typhimurium* strains TA 1535, TA 1537, TA 98 and TA100 (Taylor 1979 *cited in* SERA 1998) and of Chinese hamster ovary cells (Krahn and Fitzpatrick 1981 *cited in* SERA 1998). Sulfometuron methyl did not induce chromosomal damage in Chinese hamster ovary cells (Galloway 1981 *cited in* SERA 1998) or unscheduled DNA synthesis in rat hepatocytes (Ford 1982 as *cited in* SERA 1998).

2.2.7.8 Metabolism

In both mammals and bacteria, sulfometuron methyl is degraded by cleavage of the sulfonyl urea bridge to form sulfonamide and a dimethyl pyrimidine urea or pyrimidine amine. Sulfonamide may be further degraded by demethylation to the free benzoic acid which, in turn, may undergo a condensation reaction to form saccharin. At least in bacteria, the pyrimidine metabolites may be degraded further to hydroxypyrimidine amine and pyrimidine-ol. Although data regarding mammalian metabolism of sulfometuron methyl are limited, there is an apparent qualitative difference between mammalian and microbial metabolism that involves changes to sulfometuron methyl prior to cleavage of the sulfonyl urea bridge. In mammals, the major metabolic route seems to involve hydroxylation of a methyl group on the pyrimidine ring (Koeppe and Mucha 1991 *cited in* SERA 1998); in bacteria, the major metabolic

pathway seems to involve demethylation of the methyl ester group on the benzoate ring (Monson and Hoffman 1990 *cited in* SERA 1998).

TABLE 2-1
Acute Toxicity Categories and Definitions

Toxicity Category	I	II	III	IV
Oral LD_{50}	0 to 50 mg/kg[2]	50 to 500 mg/kg	500 to 5,000 mg/kg	> 5,000 mg/kg
Inhalation LC_{50}[1]	0 to 0.2 mg/L[3]	0.2 to 2 mg/L	2 to 20 mg/L	> 20 mg/L
Dermal LD_{50}	0 to 200 mg/kg	200 to 2,000 mg/kg	2,000 to 20,000 mg/kg	> 20,000 mg/kg
Eye effects	Corrosive, corneal opacity not reversible within 7 days	Corneal opacity reversible within 7 days; irritation persisting for 7 days	No corneal opacity; irritation reversible within 7 days	No irritation
Skin effects	Corrosive	Severe irritation at 72 hours	Moderate irritation at 72 hours	Mild or slight irritation at 72 hours

[1] LC_{50} = median lethal concentration.
[2] mg/kg = milligrams of chemical per kilogram of body weight.
[3] mg/L = milligrams of chemical per liter of air.
Source: USEPA 2003f.

TABLE 2-2
Toxicity Categories for Short-term Tests

Herbicide Active Ingredient	Acute Oral[1]	Acute Dermal[1]	Acute Inhalation[1]	Primary Eye[2]	Primary Skin[2]	Dermal Sensitizer	Reference
Dicamba	III	III	IV	II	II	No	USEPA 2001i
Diflufenzopyr	IV	IV	IV	III	IV	No	USEPA 2001c
Diquat	III	II	III	II	IV	No	USEPA 2001e
Fluridone	IV	III	III	II	IV	No	USEPA 1986 and 1988
Imazapic	IV	III	IV	III	IV	No	USEPA 2001a
Sulfometuron methyl	NA	NA	NA	NA	NA	NA	(see text)

[1] USEPA labeling guidelines acute, oral, dermal, and inhalation effects:
I. Severe; oral LD_{50} 0-50 mg/kg, dermal LD_{50} 0-200 mg/kg, and inhalation LC_{50} 0-0.2 mg/L.
II. Moderate; oral LD_{50} 50-500 mg/kg, dermal LD_{50} 200-2000 mg/kg, and inhalation LC_{50} 0.2-2 mg/L.
III. Slight; oral LD_{50} 500-5,000 mg/kg, dermal LD_{50} 2,000-20,000 mg/kg, and inhalation LC_{50} 2-20 mg/L.
IV. Very slight; oral LD_{50} >5,000 mg/kg, dermal LD_{50} >20,000 mg/kg, and inhalation LC_{50} >20 mg/L.

[2] USEPA labeling guidelines for pesticides applied to skin or eyes:
I. Irreversible corneal opacity at 7 days and corrosive to skin.
II. Corneal opacity reversible within 7 days and severe skin irritation at 72 hours.
III. No corneal opacity and moderate skin irritation at 72 hours.
IV. No irritation to the eyes and mild or slight skin irritation at 72 hours.

NA = Not Available from USEPA.

3.0 DOSE-RESPONSE ASSESSMENT

The purpose of the dose-response assessment is to identify the types of adverse health effects a chemical may potentially cause and to define the relationship between the dose of a chemical and the likelihood or magnitude of an adverse effect (response). The dose-response assessment identifies quantitative or numerical dose-response values that are used in risk calculations to derive risk estimates. The dose-response values used in the HHRA were developed by the USEPA.

Adverse effects are defined by the USEPA as either potentially carcinogenic or noncarcinogenic (i.e., potential effects other than cancer). Dose-response values for these types of effects are defined by the USEPA. None of the six herbicide a.i. evaluated in this HHRA are designated as potential carcinogens by the USEPA; therefore, this toxicity assessment focuses on noncarcinogenic effects.

3.1 Types of Dose-response Values

Under USEPA OPP guidance (USEPA 2000a), noncarcinogenic effects are evaluated differently depending on whether the assessment is of a dietary or non-dietary (occupational or residential) exposure, as described below.

3.1.1 Dietary Assessment

For noncarcinogenic effects, toxicity is represented by a PAD and may be calculated for acute effects (i.e., acute PAD) or chronic effects (i.e., chronic PAD). A PAD is an acute or chronic reference dose (RfD) divided by the Food Quality Protection Act (FQPA) Safety Factor (SF). Both the RfD and the FQPA are discussed below.

Under the provisions of the FQPA of 1996, the USEPA is directed to consider aggregate exposure, cumulative risk, and additional sensitivity of infants and children. The FQPA SF is applied to pesticides that exhibit threshold effects to "take into account potential pre- and post-natal toxicity and completeness of the data with respect to exposure and toxicity to infants and children." In applying the factor, the Agency takes into account information on the toxicity of the pesticide as well as the completeness of the toxicity and exposure databases. Generally, FQPA SFs range from 1 to 10.

Reference doses are derived by identifying a NOAEL, which is obtained from the acute or chronic toxicity studies, and dividing the NOAEL by the appropriate uncertainty factors (UFs). The NOAEL is typically derived from animal studies where animals are dosed with different amounts of the pesticide (see Section 2.2). Typically for pesticides, a 10-fold factor is applied to account for variation within the human population (intraspecies), and an additional 10-fold factor is applied to account for the differences between humans and animals (interspecies). The following equations show the definitions of PAD and RfD:

$$\text{PAD} = \frac{\text{RfD}}{\text{FQPA Safety Factor}},$$

where

$$\text{RfD} = \frac{\text{NOAEL}}{\text{Uncertainty Factors}}$$

In the acute PAD calculation, the acute RfD and the NOAEL obtained from an acute toxicity study are used in the equation. For the chronic PAD calculation, the chronic RfD and the NOAEL obtained from a chronic study are used (USEPA 2000a).

The dietary exposures evaluated in this risk assessment are ingestion of drinking water, berries, and fish for the public receptors. These exposure scenarios are further described in Section 4.0 (Exposure Assessment).

3.1.2 Non-dietary (Occupational or Residential) Assessment

For evaluating noncancer effects for non-dietary exposures, toxicity is represented by the NOAEL. The NOAEL is divided by the intake rate to calculate a MOE. No Observable Adverse Effect Levels are identified for a variety of exposure durations and exposure routes:

- Short-term oral NOAEL
- Intermediate-term oral NOAEL
- Short-term dermal NOAEL
- Intermediate-term dermal NOAEL
- Long-term dermal NOAEL
- Short-term inhalation NOAEL
- Intermediate-term inhalation NOAEL
- Long-term inhalation NOAEL

In the current USEPA OPP program, short-term is defined as 1 day to 1 month, intermediate-term is defined as 1 to 6 months, and long-term is defined as greater than 6 months (USEPA 2001h). In general, NOAELs decrease as exposure time (ET) increases. This is because the dose encountered is a factor of concentration and duration of exposure. A study conducted by the California EPA's (CalEPA) Office of Environmental Health Hazard Assessment (OEHHA) indicates that both concentration and time of exposure contribute to the overall severity of toxic effects. In fact, "Haber's Law" states that the product of the concentration and time of exposure required to produce a specific physiologic effect is equal to a constant level or severity of response (OEHHA 1999). The USEPA has not developed long-term oral NOAELs, since long-term oral exposure is similar to dietary exposure, which is represented by PADs. The short-term and intermediate-term oral NOAELs are used to represent incidental ingestion exposures, such as ingesting water while swimming. No Observable Adverse Effect Levels represent non-dietary exposures and are used to evaluate the occupational receptors and the public receptors for the following scenarios: dermal contact with spray, dermal contact with foliage, dermal contact with water while swimming, and incidental ingestion of water while swimming. These exposure scenarios are further described in Section 4.0 (Exposure Assessment).

For each of the six herbicide a.i. evaluated in this HHRA, the USEPA has developed NOAELs for a limited set of exposure durations and exposure routes. In other words, not all of the NOAELs listed above have been developed for the six herbicide a.i.

The NOAEL divided by the intake results in the MOE. Unless specified otherwise, the target MOE is 100. The target MOE accounts for uncertainties in the NOAEL. Margins of Exposure greater than the target MOE indicate no significant risk. For each of the herbicide a.i., the target MOE is listed along with the dose-response values in Table 3-1.

3.2 Available Dose-response Values

For dicamba, diflufenzopyr, diquat and imazapic, the USEPA provided documents (such as reports from the Hazard Identification Assessment Review Committee and HED) that showed the derivation of various PADs and NOAELs for different exposure routes and time frames (short-, intermediate-, and long-term). At the BLM's request, the USEPA reviewed the available toxicity information for fluridone (USEPA 2003a) and sulfometuron methyl (USEPA 2003b), and developed PADs and NOAELs for oral, dermal, and inhalation exposures. For fluridone, the USEPA did

not develop dietary PADs; therefore, a chronic oral RfD listed in USEPA's Integrated Risk Information System (IRIS) database (USEPA 2003c) is used to evaluate chronic dietary exposures for fluridone.

Table 3-1 shows the USEPA-derived PADs and NOAELs for each of the six herbicide a.i. As shown in Table 3-1 and as previously stated, none of these herbicide a.i. are considered potential carcinogens. For some of the herbicide a.i., USEPA-derived values were not available for certain exposure routes and time periods. In some cases, these values were not derived because the herbicide a.i. had not been found to be toxic through that particular route of exposure (such as dermal NOAELs for diflufenzopyr). In other cases, these values were not derived because the USEPA had determined that the use of the specific herbicide a.i. did not indicate a concern for exposure through a specific route (such as a long-term inhalation NOAEL for diflufenzopyr). However, since this risk assessment evaluated both occupational and public exposures through a variety of exposure routes, it was important to have toxicity values for certain exposures and time frames even if these values had not been derived by USEPA. Therefore, if information was available, surrogate toxicity values for certain exposures and time periods were derived in this risk assessment. The surrogate toxicity values derived in this risk assessment are shown as shaded values in Table 3-1.

3.2.1 Dicamba

The USEPA has developed various dose-response values specific to different toxicological endpoints. Table 3-1 summarizes the dose-response values for dicamba. As shown here, dicamba and diflufenzopyr are evaluated as separate chemicals, even though they are present in the same herbicide formulations. This is a reasonable approach because dose-response values for the two chemicals are based on different toxicological endpoints. For example, the acute PAD and chronic PAD for dicamba are based on neurological effects and developmental effects, respectively. For diflufenzopyr, on the other hand, the acute PAD and chronic PAD are based on developmental effects and hemolytic effects, respectively. The oral, dermal, and inhalation NOAELs for dicamba are based on developmental effects, whereas the oral and inhalation NOAELs for diflufenzopyr are based on hemolytic effects. Therefore, for the remainder of this HHRA, dicamba and diflufenzopyr will be evaluated separately.

3.2.1.1 Dose-response Values for Dietary Exposures

Acute Dietary PAD

An acute PAD of 1.0 mg/kg-day was developed based on an acute neurotoxicity study in rats. The LOAEL for this study was 300 mg/kg-day based on various neurological effects. No NOAEL was identified since this was the LDT. An RfD of 1.0 mg/kg-day was calculated by dividing the LOAEL by a UF of 300. The UF of 300 consists of two factors of 10 to account for interspecies and intraspecies differences. A factor of 3 was included because of the use of a LOAEL rather than a NOAEL. It was determined that a UF of 3 is adequate based on comparison with a rat developmental toxicity study that had similar clinical signs with a LOAEL of 400 mg/kg-day that showed no progression or worsening of the effects after 10 days of treatment (USEPA, 2001i).

The USEPA has not developed an FQPA SF for this chemical. However, based on the mild toxicological effects at the LOAEL and the adequacy of developmental toxicity studies that evaluate risks to the offspring, it is assumed that the FQPA SF is 1 and that the acute PAD is the same as the acute RfD of 1.0 mg/kg-day.

Chronic Dietary PAD

The USEPA has developed a chronic dietary PAD of 0.45 mg/kg-day. This value was based on a NOAEL of 45 mg/kg-day based on a multi-generation reproduction study in rats. Decreased offspring growth was observed at the LOAEL of 136 mg/kg-day. A chronic RfD was calculated by dividing the chronic NOAEL by a UF of 100 (45 mg/kg-day / 100 = 0.45 mg/kg-day). The FQPA SF is likely to be 1, since this study considers effects on young animals. Therefore, the chronic PAD is equal to the chronic RfD at 0.45 mg/kg-day (USEPA 2001i).

3.2.1.2 Dose-response Values for Non-dietary Exposures

Oral NOAELs

The short-term and intermediate-term oral NOAELs are 45 mg/kg-day based on the multi-generation rat reproduction study on which the chronic PAD is based. The USEPA commented that this study is of the appropriate route and duration of exposure, since effects were seen on lactation day 21 in the second generation litters and is protective of infants and children (USEPA 2001i).

Dermal NOAELs

The USEPA has identified short-, intermediate-, and long-term dermal NOAELs of 45 mg/kg-day based on the multi-generation rat reproduction study on which the chronic PAD is based. The USEPA noted that although a 21-day dermal study was available, showing no systemic toxicity at the HDT of 1,000 mg/kg-day, this dermal study did not assess reproductive and offspring effects. Offspring toxicity in the rat oral multi-generation reproduction study was noted below dosages where parental toxicity was evident. In order to be protective of these effects, the reproduction study was chosen for all time periods of exposure, including short-term, since effects in the offspring were seen on lactation day 21 (USEPA 2001i).

The dermal NOAELs should be used with a dermal absorption factor (DAF) of 15%. The USEPA calculated this DAF by dividing the LOAEL of 150 mg/kg-day in the rabbit oral developmental study by the NOAEL of 1,000 mg/kg-day in the 21-day dermal toxicity rabbit study (150 mg/kg-day / 1,000 mg/kg-day x 100 = 15%; USEPA 2001i).

Inhalation NOAELs

The USEPA has identified short-, intermediate-, and long-term inhalation NOAELs of 45 mg/kg-day based on the multi-generation rat reproduction study on which the chronic PAD is based. The USEPA states that this study is protective of effects in the offspring. In order to account for effects in the offspring in the absence of any route-specific data, the reproduction study was chosen for all time periods of exposure (USEPA 2001i).

Target MOE

The target MOE for dicamba for the non-dietary NOAELs is 100 (USEPA 2001i).

Cancer Dose-response Value

The USEPA has not developed a cancer slope factor (CSF) for dicamba. The RfD/Peer Review Committee concluded that dicamba should be classified as a Group D carcinogen based on the lack of both rat and mouse bioassays being tested at high enough levels to induce any significant toxicity in the two different species (USEPA 2001i).

3.2.2 Diflufenzopyr

Table 3-1 summarizes the dose-response values for diflufenzopyr.

3.2.2.1 Dose-response Values for Dietary Exposures

Acute Dietary PAD

An acute PAD of 1.0 mg/kg-day was calculated for use in evaluating risks from dietary exposures for females 13 to 50 years old. This value was based on an acute dietary NOAEL of 100 mg/kg-day based on a rabbit developmental study. The LOAEL for this study is 300 mg/kg-day based on the occurrence of extra ribs and other skeletal variations in the rabbit developmental study. These effects can occur from a single dose, and females of reproductive age, i.e., aged 13 to 50, are the population subgroup of concern. The UF for deriving a human dose-response value is 100. Therefore, the acute RfD is 1.0 mg/kg-day (100 mg/kg-day / 100). The acute PAD was calculated by dividing the RfD by the FQPA SF. The USEPA has determined that the FQPA SF for diflufenzopyr is 1, indicating that children are unlikely to face higher risks, which is appropriate as the results are based on a developmental study. Therefore, the acute PAD is the same as the acute RfD of 1.0 mg/kg-day (USEPA 2002b).

The USEPA has not developed an acute dietary PAD for the general population, since appropriate studies involving single exposures were not available (USEPA 2002b). The acute PAD for females 13 to 50 years old therefore is used for all receptors.

Chronic Dietary PAD

The USEPA has developed a chronic dietary PAD for all populations of 0.26 mg/kg-day. This value was based on a NOAEL of 26 mg/kg-day derived from a 52-week dog feeding study. The LOAEL of 299 mg/kg-day was based on compensated hemolytic anemia in both sexes of dogs. A chronic RfD was calculated by dividing the chronic NOAEL by a UF of 100 (26 mg/kg-day / 100 = 0.26 mg/kg-day). The chronic PAD is also 0.26 mg/kg-day, since the FQPA SF is 1 (USEPA 2002b).

3.2.2.2 Dose-response Values for Non-dietary Exposures

Oral NOAELs

The USEPA has not derived non-dietary oral NOAELs for diflufenzopyr (USEPA 2002b). However, USEPA established short- and intermediate-term inhalation NOAELs of 58 mg/kg-day based on a subchronic feeding study in dogs. Inhalation exposure assumes 100% absorption. This same 58 mg/kg-day NOAEL is recommended as the short- and intermediate-term oral NOAEL, since this value was based on a feeding study.

Dermal NOAELs

The USEPA has not identified dermal toxicological endpoints of concern, citing no effects at the limit dose of 1,000 mg/kg-day in a 21-day dermal toxicity study in rabbits. Therefore, the USEPA has determined that assessment of risk via the dermal route is not necessary (USEPA 2002b).

Inhalation NOAELs

The USEPA has developed a short-term and intermediate-term inhalation NOAEL of 58 mg/kg-day. This value is based on an oral NOAEL of 58 mg/kg-day from a subchronic oral dog study. The inhalation absorption factor (IAF) was assumed to be 100%, therefore the inhalation NOAEL is equal to the oral NOAEL. The LOAEL in this study was 403 mg/kg-day based on the occurrence of erythroid hyperplasia in the bone marrow, extramedullary hemopoiesis in the liver, and hemosiderin deposits in Kupffer cells.

The USEPA has not developed a long-term inhalation NOAEL stating that, "the use pattern does not indicate a concern for potential exposure via this route. Therefore, this risk assessment is not required" (USEPA 2002b). However, since long-term use was evaluated in this risk assessment, a long-term inhalation NOAEL was derived from available information. The USEPA developed a chronic dietary NOAEL of 26 mg/kg-day based on a 52 week dog feeding study. Making the same assumption about inhalation absorption as made in developing the short- and

intermediate-term inhalation NOAELs (i.e., 100%), a long-term inhalation NOAEL of 26 mg/kg-day can be derived from the chronic dietary NOAEL. This is consistent with the approach taken for developing inhalation NOAELs for imazapic and sulfometuron methyl.

Target MOE

The target MOE for diflufenzopyr for the non-dietary NOAELs is 100.

Cancer Dose-response Value

The USEPA has not developed a CSF for diflufenzopyr. In accordance with the *1996 Proposed Guidelines for Carcinogen Risk Assessment* (USEPA 1996a), diflufenzopyr was classified as "Not Likely" to be a human carcinogen. This classification is based on the lack of evidence of carcinogenicity in mice and rats when tested at doses that were judged to be adequate to assess carcinogenicity.

3.2.3 Diquat

Table 3-1 summarizes the dose-response values for diquat dibromide.

3.2.3.1 Dose-response Values for Dietary Exposures

Acute Dietary PAD

The USEPA has developed an acute PAD of 0.75 mg/kg-day based on an acute neurotoxicity study (MRID No. 42666801). Diquat dibromide was administered to 10 Alpk:ApfSD rats per sex per group via gavage at single dose levels of 0, 25, 75, or 150 mg/kg. The systemic NOAEL is 75 mg/kg, based on clinical signs and decreased body-weight gains at the systemic LOAEL of 150 mg/kg. The UF for deriving a human dose-response value is 100 (10 to account for interspecies differences, and 10 to account for intraspecies differences). Therefore, the acute RfD is 0.75 mg/kg-day (75 mg/kg-day / 100). The acute PAD was calculated by dividing the RfD by the FQPA SF. The USEPA has determined that the FQPA SF for diquat is 1, indicating that children are unlikely to face higher risks. Therefore, the acute PAD is the same as the acute RfD of 0.75 mg/kg-day (USEPA 2001f).

Chronic Dietary PAD

The USEPA has developed a chronic dietary PAD for all populations of 0.005 mg/kg-day. This value was based on a NOAEL of 0.5 mg/kg-day derived from a 52-week dog feeding study (MRID No. 41730301). The dose levels were 0, 0.5, 2.5, and 12.5 mg/kg-day. The LOAEL of 2.5 mg/kg-day was based on cataracts in females and decreased weights of the adrenals and epididymides in males. A chronic PAD was calculated by dividing the chronic NOAEL by an UF of 100 (0.5 mg/kg-day / 100 = 0.005 mg/kg-day). The HED Committee determined that an UF of 100 is adequate for the protection of infants and children from exposure to diquat dibromide. Therefore, because the FQPA SF is 1, the chronic PAD is 0.005 mg/kg-day (USEPA 2001f).

3.2.3.2 Dose-response Values for Non-dietary Exposures

Oral NOAELs

The USEPA has derived separate short- and intermediate-term oral NOAELs for diquat dibromide (USEPA 2001f). The short-term oral NOAEL of 1 mg/kg-day is based on a developmental toxicity study in rabbits (MRID No. 41198901). Pregnant New Zealand White rabbits were administered technical grade diquat via gavage at dose levels of 0, 1, 3, and 10 mg/kg-day from gestation days 7 through 19. The maternal toxicity NOAEL was 1 mg/kg-day, based on maternal body-weight loss and decreased food consumption at the LOAEL of 3 mg/kg-day (USEPA 2001f).

The intermediate-term oral NOAEL of 0.5 mg/kg-day is based on a chronic oral toxicity study in dogs (MRID No. 41730301), which is the same study that forms the basis for the chronic dietary PAD. The NOAEL of 0.5 mg/kg-day is based on unilateral cataracts in females and decreased adrenal and epididymides weights in males at the LOAEL of 2.5 mg/kg-day (USEPA 2001f).

Dermal NOAELs

The USEPA identified a short-term dermal NOAEL of 1 mg/kg-day based on a developmental toxicity study in rabbits (MRID No. 41198901). This is the same study on which the short-term oral NOAEL is based. In order to use this NOAEL to evaluate dermal exposure, the USEPA recommends using a dermal absoption factor of 4.1%. This value is from a dermal penetration study in rats, based on exposure pattern and duration of exposure (MRID No. 41238701). Following 24 hours of exposure, dose levels of 0.05, 0.5, and 5 mg diquat cation/rat resulted in 2.3, 2.1, and 3.3% absorption. Based on these findings, the dermal absorption of diquat dibromide through intact rat skin is considered very low (USEPA 2001f).

The USEPA has identified an intermediate- and long-term dermal NOAEL of 0.5 mg/kg-day based on a chronic oral toxicity study in dogs (MRID No. 41730301). This is the same study on which the intermediate-term oral NOAEL is based. The DAF of 4.1% should be used with this NOAEL as well (USEPA 2001f).

Inhalation NOAELs

The USEPA has developed an inhalation NOAEL of 0.024 mg/kg-day for all exposure durations (short-, intermediate-, and long-term). This value is based on a subchronic 21-day inhalation study in rats (MRID No. 40301701), where male and female Fischer 344 rats were exposed via inhalation to respirable aerosols of diquat at dose levels of 0, 0.49, 1.1, and 3.8 ug/L for 3 weeks. A subsequent study (MRID No. 40640801), in which male and female Fischer 344 rats were exposed via inhalation to respirable aerosols of diquat at dose levels of 0 and 0.1 μg/L for 3 weeks, was performed to determine a NOAEL. The NOAEL of 0.024 mg/kg-day (converted from 0.1 μg/L) is based on increased lung weights and microscopic lesions in the lungs at the LOAEL of 0.117 mg/kg-day (0.49 μg/L; USEPA 2001f).

Target MOE

A target MOE of 100 is adequate to ensure protection from occupational and residential exposures to diquat dibromide by dermal and inhalation routes (USEPA 1997b). This is based on the lack of increased sensitivity to fetuses as compared to maternal animals in developmental and multigenerational reproduction toxicity studies.

Cancer Dose-response Value

The USEPA has not developed a CSF for diquat dibromide (USEPA 2001f). The carcinogenic potential of diquat dibromide was evaluated by the HED RfD Peer Review Committee on March 31, 1994. The Committee classified diquat dibromide as a Group E (evidence of noncarcinogenicity for humans) based on a lack of evidence of carcinogenicity in studies with two species, rat and mouse.

3.2.4 Fluridone

Table 3-1 summarizes the dose-response values for fluridone.

3.2.4.1 Dose-response Values for Dietary Exposures

Acute Dietary PAD

The USEPA did not provide an acute RfD or PAD for fluridone (USEPA 2003a). The rationale for this was not provided in the USEPA memorandum.

Chronic Dietary PAD

The USEPA's Office of Pesticides has not developed a chronic dietary RfD or PAD for this herbicide a.i. (USEPA 2003a). However, the USEPA's IRIS database lists an RfD of 0.08 mg/kg-day (USEPA 2003c), which is used in this HHRA to evaluate dietary risks. This value was based on a NOAEL of 8 mg/kg-day derived from a combined chronic feeding/carcinogenicity study (MRID Nos. 00103251, 00103305) in Fischer rats. In this study, fluridone was administered continuously in the diet to rats (75/sex/group) at dose levels of 0, 8, 25, or 81 mg/kg-day for 2 years (60/sex/group), or for 52 weeks (15/sex/group). The LOAEL for this study is 25 mg/kg-day based on glomerulonephritis, atrophic testes, eye keratitis, decreased BW and organ weights. The RfD was calculated by dividing the NOAEL by a UF of 100 (10 for interspecies variation and 10 for intraspecies variation).

3.2.4.2 Dose-response Values for Non-dietary Exposures

Oral NOAELs

The USEPA has developed a short-term and intermediate-term oral NOAEL for fluridone of 25 mg/kg-day from a 90-day rat feeding study (USEPA 2003a). The USEPA does not provide additional detail on these NOAELs (USEPA 2003a).

Dermal NOAELs

The USEPA has developed separate short-term dermal NOAELs for children and adults. The short-term dermal NOAEL of 25 mg/kg-day for children is based on the same 90-day rat feeding study as the short-term and intermediate-term oral NOAEL for children (USEPA 2003a). However, the short-term dermal NOAEL of 125 mg/kg-day for workers and other adults is based on an oral developmental toxicity study in rabbits. In the developmental toxicity study, rabbits were exposed to 0, 125, 300, or 750 mg/kg-day of fluridone during gestation (MRID No. 00103302 per USEPA 2002a; MRID No. 00263157 per USEPA 2003a). Effects, including maternal weight loss and abortion, were noted at the 300 mg/kg-day dose level. The maternal NOAEL is 125 mg/kg-day. The developmental NOAEL is 125 mg/kg-day since fetal resorptions occurred in the 300 mg/kg-day dose group (USEPA 1988 *cited in* MA DEM/MA DEP 2003; USEPA 2002a).

The intermediate-term dermal NOAEL for all age groups of 25 mg/kg-day is based on the same 90-day rat feeding study as the short-term and intermediate-term oral NOAEL for children. The USEPA has not developed a long-term dermal NOAEL (USEPA 2003a). However, the long-term dietary NOAEL of 8 mg/kg-day from the combined chronic rat feeding/carcinogenicity study on which the USEPA's chronic RfD is based can be used with a DAF to address long-term dermal toxicity.

The dermal NOAELs should be used with a DAF of 40% since it is based on oral toxicological endpoints. An absorption factor of 40% was derived by dividing a maternal oral LOAEL of 300 mg/kg-day (rabbit developmental study; MRID No. 00103302 per USEPA 2002a; MRID No. 00263157 per USEPA 2003a) by the dermal NOAEL of 768 mg/kg-day from a 21-day dermal toxicity study in rabbits (described in Section 1.4.4; MRID No. 00070933). No systemic effects were noted at any dose, and 768 mg/kg-day was the HDT. The absorption factor should be considered an upper-bound estimate.

Inhalation NOAELs

The USEPA has developed a short-term inhalation NOAEL for all age groups of 125 mg/kg-day, which is based on the same oral rabbit developmental toxicity study as the short-term dermal NOAEL for adults discussed above (USEPA 2003a).

The intermediate-term inhalation NOAEL for all age groups of 25 mg/kg-day is based on the same 90-day rat feeding study as the short-term and intermediate-term oral NOAEL for children. The USEPA has not developed a long-term inhalation NOAEL (USEPA 2003a). However, the long-term dietary NOAEL of 8 mg/kg-day from the combined

chronic rat feeding/carcinogenicity study on which the USEPA's chronic RfD is based can be used with an IAF to address long-term inhalation toxicity.

The inhalation NOAELS should assume 100% absorption by the inhalation route; therefore, no adjustment to the oral NOAELs is required (USEPA 2003a).

Target MOE

The target MOE for all NOAELs is 100.

Cancer Dose-response Value

The USEPA has not developed a CSF for fluridone. In accordance with the 1986 Carcinogen Risk Assessment, fluridone was classified as a Group E chemical (no evidence of carcinogenicity) based on lack of evidence for carcinogenicity in two acceptable rodent (mice and rats) carcinogenicity studies (USEPA 1997c).

3.2.5 Imazapic

Table 3-1 summarizes the dose-response values for imazapic.

3.2.5.1 Dose-response Values for Dietary Exposures

Acute Dietary PAD

An acute RfD or PAD was not established, since an appropriate endpoint attributable to a single dose was not available. No developmental toxicity was seen in rats or rabbits and maternal toxicity in rabbits occurred on days 7 through 19 of gestation (USEPA 2001a).

Chronic Dietary PAD

The USEPA has developed a chronic dietary PAD of 0.5 mg/kg-day. This value was based on a LOAEL of 137 mg/kg-day derived from a 1-year dietary toxicity study in dogs (MRID No. 42711421). In this study, imazapic was administered via the diet to groups of six beagle dogs per sex per dose, at concentrations of 0, 5,000, 20,000, or 40,000 ppm (equivalent to mean achieved dosages of 137, 501, and 1,141 mg/kg-day in males and 180, 534, and 1,092 mg/kg-day in females). The LOAEL in this study was 137 mg/kg-day in males and 180 mg/kg-day in females based on minimal degeneration and/or necrosis of the skeletal muscle of the thigh and/or abdomen in both male and, to a lesser extent, female dogs. This histological finding was associated with minimal lymphocyte and macrophage infiltration. Minimal infiltration was also observed in the diaphragm of one dog of each sex. Decreased serum creatinine was also present in females. A NOAEL was not established in this study.

The chronic RfD was calculated by dividing the LOAEL of 137 mg/kg-day by an UF of 300, resulting in a value of 0.5 mg/kg-day. The UF of 300 consists of factors of 10 for interspecies differences, 10 for intraspecies variations, and 3 for the use of a LOAEL rather than a NOAEL for this endpoint. The use of a 3-fold UF, rather than a 10-fold factor, was due to the minimal severity of the skeletal muscle degeneration and/or necrosis and to the relatively constant severity across doses (USEPA 2001a). The USEPA has not developed an FQPA SF for this chemical. However, based on the mild toxicological effects at the LOAEL and the lack of increased risk to children versus adults, it is assumed that the FQPA SF is 1 and that the chronic PAD is the same as the chronic RfD of 0.5 mg/kg-day.

3.2.5.2 Dose-response Values for Non-dietary Exposures

Oral NOAELs

The USEPA has derived a short-term (1-7 days) and intermediate-term (7 days to several months) oral NOAEL for imazapic of 350 mg/kg-day (USEPA 2001a). This value was based on a rabbit developmental toxicity study (MRID

No. 42711423) in which groups of 20 impregnated New Zealand White rabbits were administered imazapic during gestation days 7 through 19 at daily doses of 0, 175, 350, 500, or 700 mg/kg-day. The LOAEL for maternal toxicity is 500 mg/kg-day based on decreased BW gain and food consumption during the dosing period. The NOAEL for maternal toxicity is 350 mg/kg-day.

Although there was an increase in fetal incidences of rudimentary ribs, it was determined that this effect was not related to treatment. The NOAEL for developmental toxicity is 500 mg/kg-day, which is higher than the NOAEL for maternal toxicity. Therefore, the short-term and intermediate-term oral NOAEL was determined to be 350 mg/kg-day (USEPA 2001a).

Dermal NOAELs

The USEPA has not derived short- and intermediate-term dermal NOAELs, since no effects were noted in a dermal toxicity study in rabbits. The 21-day dermal toxicity study in rabbits was conducted (MRID No. 42711420) by applying imazapic to the clipped backs of New Zealand albino rabbits at targeted doses of 0, 250, 500, or 1,000 mg/kg-day for 6 hours per day, 5 days per week, for 3 weeks. There were no systemic or developmental effects observed up to the limit dose (1,000 mg/kg-day), therefore a toxicity endpoint was not selected from this study (USEPA 2001a).

The USEPA developed a long-term dermal LOAEL of 137 mg/kg-day that is used with a DAF of 50%. The LOAEL of 137 mg/kg-day is based on a 1-year dog feeding study (which is also the basis for the chronic PAD) and considers an increased incidence of minimal degeneration and/or necrosis of the skeletal muscle of the thigh and/or abdomen. Since a NOAEL was not established in the 1-year dog feeding study, the LOAEL of 137 mg/kg-day was selected for the long-term dermal exposure scenario. This value should be used with a DAF of 50%. The USEPA derived the DAF by dividing the oral maternal LOAEL of 500 mg/kg-day (rabbit developmental study; MRID No. 42711423) by the dermal NOAEL of 1,000 mg/kg-day in the 21-day dermal toxicity study in rabbits (MRID No. 42711420). The upper-bound estimated percent dermal absorption was 50%. Additionally, a target MOE of 300 is required for this scenario because of the use of a LOAEL rather than a NOAEL (USEPA 2001a).

Inhalation NOAELs

Due to the lack of appropriate inhalation studies, the USEPA has selected oral NOAELs to be used for inhalation exposure risk assessments with appropriate absorption factors. The IAF is 100%, therefore no adjustment is needed for the oral NOAELs. For evaluating short- and intermediate-term inhalation exposures, the USEPA recommends the use of the maternal systemic toxicity NOAEL of 350 mg/kg-day based on a developmental toxicity study in rabbits. A target MOE of 100 is used for this scenario (USEPA 2001a).

For evaluating long-term inhalation exposures, the USEPA recommends the use of the systemic oral toxicity LOAEL of 137 mg/kg-day based on a 1-year oral toxicity study in dogs. A target MOE of 300 is required for this exposure scenario because of the use of a LOAEL rather than a NOAEL (USEPA 2001a).

Target MOE

A target MOE of 100 is used for the oral NOAELs, and short- and intermediate-term inhalation NOAELs. A target MOE of 300 is used for the long-term dermal and long-term inhalation NOAELs because these values are based on LOAELs rather than NOAELs.

Cancer Dose-response Value

In accordance with the 1986 Carcinogen Risk Assessment, imazapic was classified as a Group E chemical (no evidence of carcinogenicity) based on lack of evidence for carcinogenicity in two acceptable rodent (mice and rats) carcinogenicity studies.

3.2.6 Sulfometuron Methyl

The USEPA has developed various dose-response values specific for different toxicological endpoints (USEPA 2003b). Table 3-1 summarizes the dose-response values for sulfometuron methyl.

3.2.6.1 Dose-response Values for Dietary Exposures

Acute Dietary PAD

An appropriate endpoint attributable to a single dose of sulfometuron methyl was not available in the toxicology data base. Therefore, an acute RfD or PAD was not established (USEPA 2003b).

Chronic Dietary PAD

The USEPA has developed a chronic RfD of 0.05 mg/kg-day. This value was based on a NOAEL of 5 mg/kg-day derived from a 1-year study in dogs (MRID No. 00129051). The LOAEL for this study was 25 mg/kg-day based on mild hemolytic anemia. A chronic RfD was calculated by dividing the chronic NOAEL of 5 mg/kg-day by a UF of 100 (10 for interspecies variation and 10 for intraspecies variation). The USEPA has not developed an FQPA SF for this chemical. However, based on the mild toxicological effects at the LOAEL and because children would not be expected to be more prone to this effect than adults, it is assumed that the FQPA SF is 1 and that the chronic PAD is the same as the chronic RfD of 0.05 mg/kg-day.

3.2.6.2 Dose-response Values for Non-dietary Exposures

Oral NOAELs

The USEPA has developed short-term and intermediate-term oral NOAELs of 5 mg/kg-day. This value was based on a 1-year study in dogs (MRID No. 00129051). The LOAEL for this study was 25 mg/kg-day based on mild hemolytic anemia (USEPA 2003b).

Dermal NOAELs

No systemic or dermal toxicity was seen following repeated dermal applications of up to 2,000 mg/kg-day to rabbits. There were no concerns for developmental or reproductive toxicity; therefore, quantification of dermal risk is not required (USEPA 2003b).

Inhalation NOAELs

The USEPA has developed an inhalation NOAEL for all exposure durations of 5 mg/kg-day. This value was based on the same 1-year study in dogs (MRID No. 00129051) on which the RfD and oral NOAELs were based. The LOAEL for this study was 25 mg/kg-day based on mild hemolytic anemia (USEPA 2003b). In the absence of chemical-specific information, the USEPA (2003b) recommends using 100% absorption for route-to-route extrapolation.

Target MOE

The target MOE for all NOAELs is 100.

Cancer Dose-response Value

The USEPA (2003b) states that the carcinogenicity of sulfometuron methyl is not yet evaluated. However, no carcinogenic effects have been detected in either rats or mice exposed to sulfometuron methyl (USEPA 1990 as cited in Extoxnet 1996b). Therefore, it is reasonable to assume that sulfometuron methyl would not be classified as a likely carcinogen.

3.3 Inert Ingredients

In addition to the a.i., most herbicides also contain inert ingredients (i.e., those substances included in the formulation that are not the a.i.) that have various functions such as diluents, binders, dispersants, carriers, stabilizers, neutralizers, antifoamers, and buffers.

The USEPA categorizes inert ingredients into four lists (54 FR 48314):

- List 1 – Inert ingredients of toxicological concern. Any product containing a List 1 ingredient must include the label statement, "this product contains the toxic inert ingredient (name of inert)."
- List 2 – Potentially toxic inert ingredients/high priority for testing inerts.
- List 3 – Inerts of unknown toxicity. Inert ingredients on this list have not yet been determined to be of known potential toxicological concern nor have they been determined to be of minimal concern. These substances will continue to be evaluated to determine if they merit reclassification to List 1, 2, or 4.
- List 4 – Inerts of minimal risk. List 4 is subdivided into List 4A (minimal risk inert ingredients) and List 4B (inerts that have sufficient data to substantiate they can be used safely in pesticide products).

BLM scientists received clearance from USEPA to review CBI on inert compounds identified in products containing the six a.i. evaluated in this risk assessment. The information received listed the inert ingredients, their chemical abstract number, supplier, EPA registration number, percentage of the formulation and purpose in the formulation. Because this information is confidential, this information, including the name of the ingredients may not be disclosed.

EPA has a listing of regulated inert ingredients at http://www.epa.gov/opprd001/inerts/index.html. This listing categorizes inert ingredients into the four categories listed above. The number of inert ingredients present in the formulations containing the six a.i. evaluated in this risk assessment are shown below:

- List 1 – no inerts found
- List 2 – no inerts found
- List 3 – 6 inerts found
- List 4 – 29 inerts found

Therefore, the majority of the inerts are of minimal risk. A few are in the category of unknown toxicity.

TABLE 3-1
Summary of Toxicological Endpoint Data

Parameter	Diflufenzopyr	Diquat	Fluridone	Imazapic	Sulfometuron Methyl	Dicamba
Acute dietary NOAEL (mg/kg-day)	100[1]	75	NA	NA[2]	NA[2]	300[3]
Uncertainty factor	100	100	NA	NA	NA	300
Food Quality Protection Act Safety Factor	1	1	NA	NA	NA	1
Acute PAD (mg/kg-day)[4]	1	0.75	NA	NA	NA	1
Chronic dietary NOAEL (mg/kg-day)	26[5]	0.5 (0.22)[6]	8[7]	137[8]	5	45
Uncertainty factor	100	100	NA	300	100	100
Food Quality Protection Act Safety Factor	1	1	NA	1	1	1
Chronic PAD (mg/kg-day)[4]	0.26	0.005 (0.0022)[6]	0.08[9]	0.5	0.05	0.45
Short- and intermediate-term oral NOAEL (mg/kg-day)	58[10]	1 (0.5)[11]	25	350	5	45
Short term dermal NOAEL (mg/kg-day)	NA[12]	1[13]	25/125[14]	NA[15]	NA[16]	45[17]
Intermediate term dermal NOAEL (mg/kg-day)	NA[12]	0.5[13]	25[14]	NA1[5]	NA[16]	45[17]
Long-term dermal NOAEL (mg/kg-day)	NA[12]	0.5[13]	8[7]	137[18]	NA[16]	45[17]
Short term inhalation NOAEL (mg/kg-day)	58[19]	0.024	125[20]	350[21]	5[22]	45
Intermediate term inhalation NOAEL (mg/kg-day)	58[19]	0.024	25[20]	350[21]	5[22]	45
Long-term inhalation NOAEL (mg/kg-day)	26[23]	0.024	8[7]	137[24]	5[22]	45
Target margin of exposure for oral, dermal, inhalation	100[25]	100	100[25]	300/100/300[26]	100	100
CSF for oral, dermal, Inhalation	NA[27]	NA[28]	NA[28]	NA[28]	NA[29]	NA
References	USEPA 2002b	USEPA 2001f	USEPA 2003a	USEPA 2001a	USEPA 2003b	USEPA 2001i

TABLE 3-1 (Cont.)
Summary of Toxicological Endpoint Data

[1] Derived for females of reproductive age 13-50 years old. Based on a rabbit development study showing a LOAEL of 300 mg/kg-day.
[2] An endpoint attributable to a single dose was not identified.
[3] This value is a LOAEL based on an oral neurotoxicity study in rats.
[4] The PAD is the NOAEL divided by the uncertainty factor and the FQPA SF. If the FQPA SF is 1, then the PAD equals the Reference Dose (RfD), which is the NOAEL divided by the uncertainty factor.
[5] Derived for all populations. Based on a dog feeding study showing a LOAEL of 299 mg/kg-day.
[6] The numbers in parentheses are RfDs presented on IRIS (USEPA 2003c).
[7] The long-term dietary NOAEL of 8 mg/kg-day from the combined chronic rat feeding/carcinogenicity study on which USEPA's chronic RfD is based (http://www.epa.gov/iris/subst/0054.htm) is used as a chronic dietary NOAEL and as a long-term inhalation NOAEL.
[8] Lowest Observed Adverse Effect Level (LOAEL).
[9] Oral RfD value provided in IRIS (2003c).
[10] Short- and intermediate-term inhalation NOAELs of 58 mg/kg-day were established by HED (USEPA 2002c) based on a subchronic feeding study in dogs. Therefore, assuming 100% absorption via inhalation, the inhalation NOAEL is used to evaluate the oral route of exposure.
[11] The short-term oral NOAEL is 1 mg/kg-day, and the intermediate-term oral NOAEL is 0.5 mg/kg-day.
[12] No dermal or systemic toxicity was seen at 1,000 mg/kg-day in a 21-day dermal toxicity study in rabbits.
[13] This value is modified using a dermal absorption factor (DAF) of 4.1% in the exposure calculations.
[14] This value is modified using a dermal absorption factor (DAF) of 40% in the exposure calculations. The short-term dermal NOAEL is 25 mg/kg-day for children and 125 mg/kg-day for adults.
[15] No systemic toxicity was seen following repeated dermal application at 1,000 mg/kg-day over a 3-week period; therefore, dermal quantification is not required.
[16] No systemic or dermal toxicity was seen following repeated dermal applications of up to 2,000 mg/kg-day to rabbits.
[17] This value is modified using a dermal absorption factor (DAF) of 15% in the exposure calculations.
[18] The chronic dietary oral LOAEL of 137 mg/kg-day is used - this value must be modified using a dermal absorption factor of 50% in the exposure calculations.
[19] Based on a subchronic dog feeding study showing a LOAEL of 403 mg/kg-day and assuming 100% inhalation absorption.
[20] The inhalation absorption factor is 100%.
[21] The short- and intermediate-term oral NOAEL is used - the inhalation absorption factor is assumed to be 100%; no adjustments are necessary for the exposure calculations.
[22] A 100% inhalation absorption fraction is used for route-to-route extrapolation from oral to inhalation.
[23] Assuming 100% adsorption via inhalation, a long-term inhalation NOAEL of 26 mg/kg-day was derived from the chronic dietary NOAEL of 26 mg/kg-day (USEPA 2002b).
[24] The chronic dietary LOAEL of 137 mg/kg-day is used. The inhalation absorption factor is assumed to be 100%.
[25] Not listed. Assumed to be 100.
[26] Target MOE's are 100 for short- and intermediate-term inhalation and short- and intermediate-term oral and 300 for long-term inhalation and long-term dermal. The target MOE of 300 is necessary because the long-term dermal and inhalation values are LOAELs rather than NOAELs.
[27] Classified as not likely to be a human carcinogen.
[28] Classified as a Group E carcinogen - a chemical for which there is evidence of non-carcinogenicity for humans.
[29] Not yet evaluated by USEPA, but no evidence of carcinogenicity in either mice or rats.
Shading indicates where surrogate toxicity data have been used that were not provided in the USEPA documents. A discussion of this is provided in the text.
Short term is defined as 1 day to 1 month, intermediate term is defined as 1 to 6 months, and long term is defined as over 6 months (USEPA 2001h).
NA = Not Applicable, according to USEPA risk assessments; LOAEL = Lowest Observed Adverse Effect Level; CSF = Cancer Slope Factor: NOAEL = No Observed Adverse Effect Level; FQPA SF = Food Quality Protection Act Safety Factor; PAD = Population Adjusted Dose; IRIS = Integrated Risk Information System; RfD = Reference Dose.

4.0 EXPOSURE ASSESSMENT

The purpose of the exposure assessment is to predict the magnitude and frequency of potential human exposure to the herbicide a.i. under consideration in the HHRA. The first step in the exposure assessment process is to identify potential exposure pathways that are appropriate for planned BLM use of the herbicide a.i. This step also involves identifying potential receptors (i.e., people who may contact the impacted environmental media of interest) and the exposure routes by which environmental media may be contacted (i.e., ingestion, dermal contact, inhalation). Those potential exposure pathways that are judged to be complete are evaluated quantitatively in the risk assessment. According to the USEPA (1989), for an exposure pathway to be complete, the following conditions must exist:

- A source and mechanism of chemical release to the environment
- An environmental transport medium (e.g., air, water, soil)
- A point of potential receptor contact with the medium
- A human exposure route at the contact point (e.g., inhalation, ingestion, dermal contact)

Where one or more of these conditions is not met, an exposure pathway is not complete.

The second step in the exposure assessment process involves quantifiying exposure for each of the receptors and exposure pathways. To estimate the potential risk to human health that may be posed by the planned herbicide use, it is first necessary to estimate the potential exposure dose of each herbicide a.i. for each receptor. The exposure dose of each herbicide a.i. is estimated for each receptor via each exposure route/pathway by which the receptor is assumed to be exposed. Exposure dose equations combine the estimates of herbicide a.i. concentration in the environmental medium of interest with assumptions regarding the type and magnitude of each receptor's potential exposure to provide a numerical estimate of the exposure dose. The exposure dose is defined as the amount of herbicide a.i. taken into the receptor and is expressed in units of milligrams of herbicide a.i. per kilogram of BW per day (mg/kg-day). The exposure doses are combined with the dose-response values to estimate potential risks for each receptor.

To understand how humans may be exposed to herbicide a.i. as a result of the BLM vegetation treatment program, it is necessary to understand herbicide use within the BLM. Within the BLM vegetation treatment program, public lands are classified into various land programs. Within each program, aerial-, ground- or boat-based applications may be used. Various application vehicles (airplane, helicopter, all-terrain vehicle (ATV), boat, horse, or human) can be used for each application type, and for each vehicle, there are different application methods, including deposition (from an airplane or helicopter), boom/broadcast, and spot applications. Similarly, there are different BLM job descriptions associated with each application method. It is assumed that occupational receptors may be incidentally exposed to the herbicide a.i. used through dermal contact and inhalation exposure pathways. These potential exposures are evaluated for each herbicide a.i. under routine use, and it is assumed that use is consistent with label directions. Reference herbicide labels are provided in Appendix A; additional manufactures may formulate the herbicide a.i. into herbicides under different trade names. In addition, an accidental spill scenario, assuming an herbicide a.i. spill to worker skin, is evaluated for the occupational receptors. The BLM vegetation treatment program is discussed in Section 4.1. The potential occupational receptors and exposure scenarios are discussed in Section 4.2.

Members of the public may also be incidentally exposed to herbicide a.i. used on public lands. Such receptors may include hikers, hunters, berry pickers, swimmers, anglers, area residents, and Native Americans using natural resources on public lands. Exposures to both spray drift and direct spray/accidental spill scenarios are evaluated. The potential public receptors are discussed in Section 4.3.

The methods used to estimate concentrations of herbicide a.i. to which occupational and public receptors could be exposed are discussed in Section 4.4.

4.1 Overview of the BLM Vegetation Treatment Program

This section identifies the land programs, application types, application vehicles, and application methods for herbicide use in the BLM vegetation treatment program.

4.1.1 Land Programs

The BLM vegetation treatment program covers six land types or programs:

- Rangeland
- Public Domain Forestland
- Energy and Mineral Sites
- Rights-of-way
- Recreation and Cultural Sites
- Aquatic Sites

Herbicides are used in rangeland improvement and silvicultural practice to improve the potential for success of desired vegetation by reducing competition for light, moisture, and soil nutrients with less desirable plant species. Herbicides are used to manage or restrict noxious plant species and to suppress vegetation that interferes with manmade structures or transportation corridors.

Weed and vegetation management programs are developed to address the occurrence of noxious, invasive, and undesirable species which have a negative impact on native vegetation, human activities, and domestic livestock. Examples of plant species of concern include, downy brome, giant salvinia, leafy spurge, purple loosestrife, Russian and spotted knapweed, tamarisk, and yellow starthistle. The noxious weed and poisonous plant control program is included as part of the vegetation treatment methodology that the BLM uses to maintain the areas under its jurisdiction. The BLM uses herbicides, a component in an integrated weed management program, as one of the options available in its noxious weed management program and uses them in varying degrees in all land treatment categories. Herbicide use under the six land programs is discussed below.

As indicated previously, separate risk assessments have been conducted on dicamba and diflufenzopyr. While these a.i. are applied together, they have different toxicological endpoints and there are no appropriate toxicological data with which to evaluate the mixture. However, in the following text, these a.i. are referred to as "diflufenzopyr + dicamba" because they are always applied together.

4.1.1.1 Rangeland

Rangeland vegetation treatment operations provide forage for domestic livestock and wildlife by removing undesirable competing plant species and preparing seedbeds for desirable plants. Approximately, 89% of the herbicide treated acreage in the BLM vegetation treatment program falls in the rangeland improvement category.

Of the herbicide a.i. being evaluated, imazapic and diflufenzopyr + dicamba are registered for use under rangeland situations. Proposed application methods include the following vehicles and methods, described in Section 1.1.2: airplane, helicopter, truck (boom/broadcast or spot applications), ATV (boom/broadcast or spot applications), horseback (spot applications), and backpack (spot applications). However, diflufenzopyr + dicamba would not be applied via airplane or helicopter.

4.1.1.2 Public Domain Forestland

Public-domain forestland vegetation treatment operations, designed to ensure the establishment and healthy growth of timber crop species, are one of the BLM's least extensive programs for herbicide treatment. These operations include site preparation, plantation, maintenance, conifer release, pre-commercial thinning, and non-commercial tree removal. Site preparation treatments prepare newly harvested or inadequately stocked areas for planting new tree crops. Herbicides used in site preparation reduce vegetation that would compete with conifers. In the brown-and-burn method of site preparation, herbicides are used to dry the vegetation, to be burned several months later. Herbicides are used in plantations some time after planting to promote the dominance and growth of already established conifers (release). Pre-commercial thinning reduces competition among conifers, thereby improving the growth rate of desirable crop trees. Non-commercial tree removal is used to eliminate dwarf mistletoe infested host trees. These latter two silvicultural practices primarily use manual applications methods (described in Section 4.1.2). Herbicide uses in public-domain forests constitute less than 4% of the vegetation treatment operations in the BLM program.

Imazapic and sulfometuron methyl are proposed for use on public-domain forestland. Proposed application methods include the following vehicles and methods: airplane, helicopter, truck (boom/broadcast and spot applications), ATV (boom/broadcast or spot applications), horseback (spot applications), and backpack (spot applications), with the exception that sulfometuron methyl would not be applied via airplane.

4.1.1.3 Energy and Minerals Sites

Vegetation treatments in energy and minerals sites include the preparation and regular maintenance of areas for use as fire control lines or fuel breaks, or the reduction of vegetation species that could pose a hazard to fire control operations. More than 50% of the vegetation treatment programs for energy and minerals sites are herbicide applications.

Of the herbicide a.i. being evaluated, imazapic, diflufenzopyr + dicamba, and sulfometuron methyl are proposed for use under the conditions described on energy and mineral sites. Proposed application methods include the following vehicles and methods, described in Section 4.1.2: airplane, helicopter, truck (boom/broadcast or spot applications), ATV (boom/broadcast or spot applications), horseback (spot applications), and backpack (spot applications). However, sulfometuron methyl would not be applied via airplane, and diflufenzopyr + dicamba would not be applied via airplane or helicopter.

4.1.1.4 Rights-of-way

Rights-of-way (ROW) treatments include roadside maintenance and maintenance of power transmission lines, waterways, and railroad corridors. In roadside maintenance, vegetation is removed or reduced from ditches and shoulders to prevent brush encroachment into driving lanes, to maintain visibility on curves for the safety of vehicle operators, to permit drainage structures to function as intended, and to facilitate maintenance operations. Herbicides have been used in nearly 50% of the BLM's roadside vegetation maintenance programs.

Imazapic, diflufenzopyr + dicamba, and sulfometuron methyl are proposed for use on ROW sites. Proposed application methods include the following vehicles and methods, described in Section 1.1.2: airplane, helicopter, truck (boom/broadcast or spot application), ATV (boom/broadcast or spot applications), horseback (spot applications), and backpack (spot applications). However, sulfometuron methyl would not be applied via airplane, and diflufenzopyr + dicamba would not be applied via airplane or helicopter.

4.1.1.5 Recreation and Cultural Sites

Recreation and cultural site maintenance operations provide for the safe and efficient use of BLM facilities and recreation sites and for permittee/grantee uses of public amenities, such as, ski runs, waterways, and utility terminals. Vegetation treatments are made for the general maintenance and visual appearance of the areas and to reduce potential threats to the site's plants and wildlife, as well as, visitor's health and welfare. Vegetation treatments in these areas are also for fire and invasive species management.

The BLM uses herbicides on approximately one-third of the total recreation site acreage identified as needing regular treatment operations. Imazapic, diflufenzopyr + dicamba, and sulfometuron methyl are proposed for use on recreation and cultural sites. Proposed application methods include the following vehicles and methods, described in Section 4.1.2: airplane, helicopter, truck (boom/broadcast or spot application), ATV (boom/broadcast or spot applications), horseback (spot applications), and backpack (spot applications). However, sulfometuron methyl would not be applied via airplane, and diflufenzopyr + dicamba would not be applied via airplane or helicopter.

4.1.1.6 Aquatic Sites

Aquatic vegetation management involves addressing the vegetation in a variety of situations ranging from rivers, streams, and canals to ponds, lakes, and water holdings. Impacts addressed through the management of aquatic vegetation include, but are not limited to, the following: altering the flow of water, displacement of native/desirable vegetation, and reduction in recreational activities.

Fluridone and diquat are proposed for use on aquatic sites. Proposed application methods include the following vehicles and methods, described in Section 4.1.2: airplane, helicopter, boat (boom/broadcast or spot applications), truck (boom/broadcast or spot applications), ATV (boom/broadcast or spot applications), horseback (spot applications), and backpack (spot applications). However, fluridone would not be applied via spot applications using a boat.

4.1.2 Application Methods

The BLM conducts pretreatment surveys in accordance with BLM Handbook H-9011-1 before making a decision to use herbicides on a specific land area. The herbicides can be applied by a number of different methods, and the selected technique is dependent upon a number of variables, including the following:

- Treatment objective (removal or reduction)
- Accessibility, topography, and size of the treatment area
- Characteristics of the target species and the desired vegetation
- Location of sensitive areas in the immediate vicinity (potential environmental impacts)
- Anticipated costs and equipment limitations
- Meteorological and vegetative conditions of the treatment area at the time of treatment

Herbicide applications are scheduled and designed such that there are minimal potential impact on non-target plants and animals, while remaining consistent with the objectives of the vegetation treatment program. Herbicides are applied either from the air or on the ground. The herbicide formulations may be in a liquid or granular form, depending upon resources and program objectives. Aerial methods employ boom-mounted nozzles for liquid formulations or rotary broadcasters for granular formulations, carried by helicopters or airplanes. Ground application methods include vehicle- and boat-mounted, backpack, and horseback application techniques. Vehicle- and boat-mounted application systems use fixed-boom or hand-held spray nozzles mounted on trucks or ATVs. Backpack systems use a pressurized sprayer to apply an herbicide as a broadcast spray directly to one or a group of individual plants. Aerial application methods are discussed in Section 4.1.2.1, ground application methods are discussed in Section 4.1.2.2, and aquatic application methods are discussed in Section 4.1.2.3.

4.1.2.1 Aerial Application Methods

Aerial application methods can be conducted using either fixed-wing airplanes or helicopters. The BLM treats more than 98% of its range management sites by air. Helicopters are preferred on rangeland projects (more than 60% of the time) because the many treatment units are far apart and are often small and irregularly shaped.

The size and type of these aircraft may vary, but the equipment used to apply the herbicides must meet specific guidelines. Contractor-operated helicopters or fixed-wing aircraft are equipped with an herbicide tank or bin (depending on whether the herbicide is a liquid or granular formulation). For aerial spraying, the aircraft is equipped with cylindrical jet-producing nozzles no less than $^{1}/_{8}$-inch diameter. The nozzles are directed with the slipstream, at a maximum of 45 degrees downward for fixed-wing, or up to 75 degrees downward for helicopter application, depending on the flight speed. Nozzle size and pressure are designed to produce droplets with a diameter of 200 to 400 microns. For fixed-wing aircraft, the spray boom is typically ¾ of the wingspan, and for helicopters, the spray boom is often ¾ of the rotor diameter. All spray systems must have a positive liquid shut-off device that ensures that no herbicide continues to drip from the boom once the pilot has completed a swath (i.e., specific spray path). The nozzles are spaced to produce a uniform pattern for the length of the boom.

Using helicopters for herbicide application is often more expensive than using fixed-wing aircraft, but helicopters offer greater versatility. Helicopters are well adapted to areas dominated by irregular terrain and long, narrow, and irregularly shaped land patterns, a common characteristic of public lands. Various helicopter aircraft types are used, including, Bell, Sikorsky, and Hiller models. These helicopters must be capable of accommodating the spray equipment and the herbicide tank or bin and of maintaining an air speed of 40 to 50 miles per hour at a height of 30 to 45 feet above the vegetation (depending upon the desired AR), and they must meet BLM safety performance standards.

Fixed-wing aircraft include the typical, small "cropduster" type aircraft. Fixed-wing aircraft are best suited for smoother terrain and larger tracts of land where abrupt turning is not required. Because the fixed-wing aircraft spraying operations are used for treating larger land areas, the price per acre is generally lower than for helicopter spraying. Aircraft capability requirements for fixed-wing aircraft are similar to helicopter requirements, except that an air speed of 100 to 120 miles per hour is necessary, with spraying heights of 10 to 40 feet generally used to produce the desired ARs.

Batch trucks are an integral part of any aerial application operation. They serve as mixing tanks for preparing the correct proportions of herbicide and carrier, and they move with the operation when different landing areas are required.

The number of workers involved in a typical aerial spray project varies according to the type of activity. A small operation may require up to six individuals, while a complex operation may require as many as 20 to 35 workers. An aerial operations crew for range management, noxious weed management, and ROW maintenance usually consists of five to eight individuals. Typically, personnel on a large project include a pilot, a mixer/loader, a contracting officer's representative, an observer-inspector, a one- to six-member flagging crew, one or two law enforcement officers, one or two water monitors, and one or two laborers. Optional personnel include an air operations officer, a radio technician, a weather monitor, and a recorder. Workers evaluated in the HHRA for aerial applications include a pilot and a mixer/loader, as these are the receptors most likely to be exposed to herbicides. Other personnel are expected to have less or similar herbicide exposure.

4.1.2.2 Ground Application Methods

There are two types of ground application methods, including, human application methods (backpack and horseback) and vehicle application which includes, ATV-based application methods (spot-treatment or boom/broadcast treatment), and truck-mounted application methods (spot-treatment or boom/broadcast treatment). These are described in greater detail below.

Human Application Methods

Humans using either backpack or horseback application methods may apply herbicides. The backpack method requires the use of a backpack spray tank for carrying the herbicide with a handgun applicator with a single nozzle for herbicide application. These techniques are best adapted for very small scale spraying in isolated spots and those areas that are not accessible by vehicle. They are primarily used for spot treatments around signposts, spraying competing

trees in public domain forestland, delineators, power poles, scattered noxious weeds, and other areas that require selective spraying.

Backpack treatment is the predominant ground-based method for silviculture and range management. The principle hand application techniques are injection and stump treatment. Injection involves applying an herbicide with the hand-held container or injector through slits cut into the stems of target plants. Individual stem treatment by the injection method is also used for thinning crop trees or removing the undesirable trees. Stump treatment entails directly applying liquid herbicide to the cut stump of the target plant to inhibit sprouting. An herbicide can be applied by dabbing or painting the exposed cambium of a stump or using a squeeze bottle on a freshly cut cambium surface. Along with liquid formulations, certain a.i. are formulated in a granular form that allows for direct application to the soil surface. Pressurized backpack treatment operations typically involve a supervisor (who may also function as a mixer/loader), an inspector, a monitor, and two to 12 crewmembers. The receptor evaluated in this risk assessment is a combined applicator/mixer/loader.

Vehicle Application Methods

Herbicide treatments may use ground-based spray applications using either a truck or an ATV. Vehicular application is made using a boom with several spray nozzles (boom/broadcast treatment) or a handgun with a single nozzle (spot treatment). Ground vehicle spray equipment can be mounted on ATVs or trucks. Because of its small size and agility, the ATV can be adapted to many different situations.

The boom spray equipment used for vehicle operations is designed to spray wide strips of land where the vegetation does not normally exceed 18 inches in height and the terrain is generally smooth and free of deep gullies. Ground spraying from vehicles occurs along highway ROW, energy and mineral sites, public domain forestlands, and rangeland sites.

Ground spraying operations are also conducted from vehicles using spot-gun spraying. The spot-gun technique is best adapted for spraying small, scattered plots. It may also be used in spraying signposts and delineators within highway ROW and around wooden power lines as a means of reducing fire hazards within power line ROW. This technique is also used to treat scattered noxious weed vegetation, but it is limited to those areas that are accessible by vehicles.

Rights-of-way maintenance projects frequently use vehicle-mounted application techniques. A truck with a mixing/holding tank uses a front mounted spray boom or a hand-held pressurized nozzle to treat roadside vegetation on varying slopes. However, using this equipment for off-road ROW projects is limited to gentle slopes (less than 20%) and open terrain. Workers typically involved, include a driver/mixer/loader and an applicator. Therefore, receptors evaluated in this HHRA include an applicator, a mixer/loader, and a combined applicator/mixer/loader.

4.1.2.3 Aquatic Application Methods

Aquatic vegetation, at moderate growth levels, is useful because it produces oxygen, food, and cover for fish and other aquatic organisms. However, in overabundance, aquatic plants can become weedy, crowd out desirable plants, adversely affect other aquatic life, and interfere with human uses of water.

Aquatic Application Techniques

There are four zones in a body of water that may be treated for the management of aquatic weeds: water surface, total water volume, bottom 1 to 3 feet of water, and the bottom sediment surface.

- When working in the water surface zone, generally, only a fourth to a third of the surface area (SA) should be treated at a time. Applications are made to floating or emergent weeds with the spray mixture being applied directly to the plants.

- The whole body of water is treated when working in this particular zone. Treatments are usually made to a fourth to a third of the total water volume at a time. Applications can be made through the metering or

injecting of the herbicide into the water from booms trailing behind the boat or as a spray over the water surface. Applications of this type are made to submersed aquatic plants and algae.

- Treating the deepest 1 to 3 feet of water is the principle behind making applications in the bottom-layer zone. Such treatments are generally made by attaching several flexible hoses at specific intervals on a rigid boom. Each hose is equipped with a nozzle and may be weighted to reach the depth desired. The length of hose and the speed of the boat carrying the application equipment also affect the depth of application. Such applications are beneficial because they apply the herbicide in a layer nearer the area where the herbicide can be taken up by the weedy species.

- The final zone, bottom sediment surface, refers to applications made to the bottom sediment of a drained pond, lake or channel.

Aquatic Application Equipment

To treat small areas, a compressed-air sprayer with a hand-operated pump may be all that is needed. Higher-quality compressed-air sprayers with CO_2 gas for constant pressure are available, but are more expensive. For larger areas, a boat-mounted pump-and-tank rig with one line may be used to treat emergent plants on a spot treat basis. A boom attached to the boat may be used when broadcast applications are made to the surface of the water. Booms with flexible hoses attached to the boom may be used to make the application below the water surface.

Applications of granules and slow-release pellets can be made either using a cyclone spreader or by hand. The granules sink to the bottom, where the chemical is slowly released in the relatively small volume of water where the new shoots are beginning to grow.

Vegetation Management – Static Water

Static water is water in ponds, lakes, or reservoirs that has little or no inflow and outflow. Floating and emersed vegetation is managed by direct foliage applications of the spray mixture by aircraft, with ground equipment—operated from the bank if the pond is small or if the weeds occur only around the margins, or from a boat—using various types of booms or hand applicators.

Submersed vegetation and algae can be managed through spray or granular applications. Spray applications can be made by aircraft, boat, or ground application equipment. Applications can made under the water surface by injection through a hose pulled behind a boat or by a series of hoses attached to a boom that is attached to the boat. Granular herbicides may be broadcast by hand or manual spreaders over small areas. Special granule spreaders mounted on aircraft or boats are used for large-scale applications.

Vegetation Management – Flowing Water

Aquatic vegetation in flowing water is difficult to manage. Floating and emersed vegetation, when treated in flowing water, require the same treatment techniques as they do in the static water. Submersed vegetation and algae can be controlled effectively in flowing water only by continuously applying enough herbicide at a given spot to maintain the needed concentration and contact time.

4.1.3 Herbicide Use Parameters

The ARs are dependent on the target species, the presence and condition of non-target vegetation, the soil type, the depth to the water table, and the presence of other water sources. Table 4-1 summarizes the vegetation treatment program for each of the herbicide a.i. Both typical and maximum ARs (in units of pounds of a.i. per acre [lb a.i./acre]) are provided for each application scenario, vehicle, and method in each land program. As can be seen in the table, and as discussed above, not all herbicide a.i. are used for all potential applications. The ARs for fluridone depend on the type of water body (i.e., pond, stream, lake). Therefore, the highest typical and maximum ARs for fluridone were employed (highest typical is for a pond, and highest maximum is for a partial lake/reservoir).

4.2 Occupational Receptors

A receptor and the exposure pathways by which that receptor may come into contact with herbicide a.i. used in the BLM vegetation treatment program define an exposure scenario. Both routine use and accidental exposure scenarios are included in the occupational evaluation.

4.2.1 Routine-use Exposure Scenarios

For aerial applications, occupational receptors that may come into contact with herbicide a.i. include:

- Pilot
- Mixer/loader

For ground applications by backpack, as the operation is generally very small in scale, the occupational receptor is assumed to be an:

- Applicator/mixer/loader

For the remaining application methods (horseback; and spot and boom/broadcast methods for ATV, truck mount and boat applications), the herbicide treatment job could be large enough to support a crew, in which case the applicator may be a person different from the mixer/loader. Alternatively, the job may be small enough that the applicator and the mixer/loader are the same person. Therefore, for these application methods, the following occupational receptors are evaluated:

- Applicator
- Mixer/loader
- Applicator/mixer/loader

Table 4-2 summarizes the application types, vehicles, and methods, identifies the occupational receptors and potential exposure pathways evaluated, and provides exposure assumptions for the occupational receptors. These exposure assumptions were derived using information from the BLM concerning proposed use of the herbicide a.i. and UE information from the *Pesticide Handlers Exposure Database* (PHED), which is a generic database containing empirical dermal and inhalation exposure data for workers mixing, loading, or applying pesticides (USEPA 1998a).

Workers are assumed to weigh 70 kg, which is the weight recommended by the USEPA in its Standard Default Exposure Assumptions (USEPA 1991). Estimates of the number of hours per day a worker may be engaged in applying herbicides, the number of days per year the worker applies herbicides, and the years of potential exposure were provided by the BLM. The BLM also provided data regarding the number of AT per hour.

A description of the PHED is provided in a peer-reviewed article by Leighton and Nielsen (1995). The PHED was developed by the PHED task force, which consists of representatives from the USEPA, Health Canada, the California Department of Pesticide Regulation, and member companies of Crop Life America. To add consistency to the risk assessment process, the USEPA, in conjunction with the PHED task force, has evaluated all data within the system and developed surrogate exposure tables that contain a series of standard UE values for various exposure scenarios. The majority of the UE values used in this risk assessment have been taken from this "surrogate" table, which is presented here as Table 4-3. In addition to the values presented in this table, the USEPA recommended UEs separately for aquatic applications of diquat and fluridone. Generally, UEs are expressed in units of milligrams per pound (mg/lb) a.i. and equate the milligrams of a.i. absorbed by an occupational receptor to the pounds of a.i. handled in a given day or exposure scenario.

Table 4-3 lists the UEs used in this risk assessment. For the dermal exposure pathway for terrestrial herbicide a.i., two sets of UEs are listed assuming that worker personal protective equipment (PPE) requires gloves or does not require gloves. The sulfometuron methyl label does not require the use of gloves, therefore, the UEs for workers not wearing gloves were used for this herbicide a.i. Unit exposures based on workers wearing gloves were used for the remaining terrestrial herbicide a.i., which are diflufenzopyr + dicamba and imazapic, because the labels for these three herbicide a.i. state that gloves must be worn when applying the herbicides.

The UEs for aquatic applications were developed for this HHRA after consultation with the USEPA (J. Evans personal communication 2003i). For aquatic use of diquat, the USEPA recommended the use of dermal UE values (in units of mg/hr) presented in the Reregistration Eligibility Decision (RED) document for diquat (USEPA 1995). Specifically, the UEs for hydrilla control—applicator and hydrilla control—mixer were used. There are no inhalation UEs for this application. The USEPA (1995) obtained these UEs from a study evaluating worker exposure to paraquat and diquat in Florida (Wojeck et al. 1983). For aquatic use of fluridone, the USEPA recommended the use of UEs specific for granular application listed in PHED (USEPA 1998a). The diquat label requires the use of gloves. The fluridone label does not discuss the use of PPE, but states that skin contact should be avoided.

4.2.2 Accidental Exposure Scenarios

Accidental exposures for occupational receptors could occur via spills, hose breaks on application equipment, or direct spray onto a worker. As a worst case scenario for an accidental exposure, a direct spill event on an occupational receptor is evaluated. The spill scenario evaluated by the BLM in the EIS for the *Final EIS Vegetation Treatment on BLM Lands in Thirteen Western States* (USDI BLM 1991) assumed that 0.5 L of the formulation is spilled on a worker receptor. It is assumed that the 80% of the spill lands on clothing and 20% lands on bare skin. The penetration rate through clothing is assumed to be 30%.

4.3 Public Receptors

Public lands administered by the BLM are diverse and include rangeland, public domain forestland, energy and minerals sites, rights-of-way, and recreational and cultural sites. Lakes, ponds, and waterways may also be present on these lands. Public land is used by the public for a variety of occupational, recreational, and cultural activities. Hunters and hikers enjoy these public lands as well as anglers and swimmers. Harvesting of natural resources by the public occurs on these lands including berry picking, harvesting of fish for consumption, and the gathering of materials for Native American crafts such as basketweaving.

When herbicides are used as part of a vegetation treatment program on public lands, the BLM takes care to flag the area to be treated and to post the area with warnings about when re-entry can occur safely.

This HHRA evaluates the potential risk to public receptors using public lands treated with herbicides by developing exposure scenarios that combine potential receptors and exposure pathways to identify potential worst-case exposures to the herbicide a.i. addressed in this PEIS. Two types of public use exposure scenarios are addressed:

- Potential exposure during routine use of public lands to herbicide a.i. that may have drifted outside of the area of application
- Accidental scenarios where public receptors may prematurely enter a sprayed area, be sprayed directly, or may contact water bodies that have accidentally been sprayed directly or into which an herbicide a.i. has accidentally been spilled

Although all of these public scenarios are expected to occur rarely, they are nonetheless used as the basis for evaluating potential public health risks associated with herbicide use in the BLM vegetation treatment program.

Based on consideration of potential public uses of BLM lands and consistent with the *Final EIS Vegetation Treatment on BLM Lands in Thirteen Western States* (USDI BLM 1991, see Section 5), receptors evaluated in this HHRA include the following:

- Hiker/hunter
- Berry picker - child and adult
- Angler
- Swimmer - child and adult
- Nearby resident - child and adult
- Native American – child and adult

Although there are many different exposure scenarios and receptors that could be evaluated, these receptors cover a range of potential exposures that could occur under worst case conditions on public lands. As shown in Table 4-4, it is assumed that these receptors could be exposed through one or more of the following exposure pathways:

- Dermal contact with spray
- Dermal contact with foliage
- Dermal contact with water while swimming
- Occasional ingestion of drinking water or incidental ingestion of water while swimming
- Ingestion of berries
- Ingestion of fish

Although all public receptor exposures to herbicide a.i. used on public lands are considered to be accidental, public receptor exposures are evaluated under two scenarios. Routine-use exposures are assumed to occur when public receptors come into contact with environmental media that have been impacted by spray drift. As discussed in Section 3.0, dose-response values are available for short-, intermediate-, and long-term exposures. While it is possible that public receptors use public lands under intermediate- and long-term time frames, it is unlikely that public receptors would be exposed to herbicides under the routine use scenario for more than a short-term exposure, which is defined as 1 day to 1 month (USEPA 2001h). Therefore, short-term dose-response values are used to evaluate the public receptors under the routine use exposure scenario. To account for the unlikely possibility that public receptors could repeatedly enter areas that have been recently sprayed, the Uncertainty Analysis (Section 5.5) includes an evaluation of the public receptors under an intermediate and a long-term exposure scenario. Accidental exposures are assumed to occur when public receptors come into contact with environmental media that have been subject to direct spray or spills. Table 4-4 shows for each herbicide a.i. the receptors and exposure pathways evaluated. Each of these scenarios is discussed below.

4.3.1 Routine-use Exposure Scenarios

Signage is used to identify areas that are directly sprayed under the BLM vegetation treatment program and to warn against reentry. It is assumed that under routine conditions, these warnings are heeded. Therefore, public exposures under routine use scenarios are assumed to occur 'off-site,' where 'on-site' is the area that has been directly sprayed.

Although all precautions are taken to limit the amount of spray drift from an herbicide application, spray drift can result in deposition of herbicide on areas outside of the directly sprayed area. Spray drift is associated with larger spraying efforts, such as those from aerial or boom/broadcast applications. It is assumed that a public receptor could walk through vegetated areas upon which spray drift had settled. If the spray drift deposits in areas where there are wild berries, a public receptor could ingest those berries. Spray drift could also settle on bodies of water, and those water bodies could be contacted by a public receptor either while swimming or could be used as a source of water for drinking while hiking. Fish could also be ingested from spray drift-impacted bodies of water. Because spray drift could potentially affect several environmental media, the exposure scenarios developed for each receptor have assumed exposure to multiple environmental media.

The Native American scenario was developed following recommendations by the USEPA (2003e). The specific receptor is a Native American basketweaver involved in gathering plant materials and other activities related to weaving baskets. The USEPA suggests evaluating the dermal contact with foliage exposure pathway. In its memorandum, the USEPA states:

> "It is expected that the oral intake of herbicides will be minimal by comparison to the above dermal exposure pathway. That is because basketweavers tend to *"spit-off"* plant residues (due to after taste) when mouth stripping plant materials (personal communication with M. Dong, California Department of Pesticide Regulation)."

For completeness, in addition to the dermal contact pathway recommended by the USEPA (2003e), the Native American (adult and child) is also assumed to be exposed through spray drift, berry ingestion, dermal contact while swimming, water for drinking, and fish ingestion.

4.3.2 Accidental Exposure Scenarios

In addition to exposures due to inadvertent spray drift, this HHRA also evaluates potential acute accidental exposures by public receptors to the herbicide a.i. Accidental exposure could occur through direct spray and spills. The same types of receptors introduced above are also evaluated for the accidental scenarios. However, because direct spray or spills are localized, exposures to multiple media are not assumed in these scenarios. Table 4-4 shows the receptors, exposure pathways, and herbicide a.i. that are evaluated for each of the exposure scenarios. It is assumed that each of the herbicide a.i. could be directly sprayed onto humans, foliage, and berries, and each of the herbicide a.i. could be directly sprayed or spilled into a water body. For the aquatic herbicide a.i. (fluridone and diquat), the direct spray pathway is a reentry scenario.

4.3.2.1 Direct Spray

Direct Spray on Receptors

In this scenario it is assumed that a receptor is accidentally sprayed with herbicide a.i. because the receptor has entered a spray area and is beneath a spray aircraft or other mode of application. Direct spray contact is evaluated for the following receptors:

- Adult receptor - hiker/hunter, berry picker, angler, nearby resident, and Native American
- Child receptor - berry picker, nearby resident, and Native American

Contact with Directly Sprayed Vegetation

Re-entry is a term used to describe entering an area that has just been sprayed (i.e., an "on-site" area, in contrast with the scenarios in the previous section where exposure to areas of "off-site" spray drift deposition is evaluated). Contact with just-sprayed vegetation may result in dermal exposure by hikers, berry pickers, and anglers. In addition, berry pickers may ingest directly sprayed fruit. This scenario is also evaluated for the aquatic herbicide a.i., diquat and fluridone, assuming inadvertent spraying of terrestrial vegetation.

Dermal contact with just-sprayed vegetation is evaluated for:

- Adult receptor - hiker/hunter, berry picker, angler, nearby resident, and Native American
- Child receptor - berry picker, nearby resident, and Native American

Ingestion of directly sprayed berries is evaluated for:

- Adult receptor - berry picker, nearby resident, and Native American
- Child receptor - berry picker, nearby resident, and Native American

Direct Spray onto Water Body

Direct spray onto water bodies could occur inadvertently for the three herbicide a.i. that are used for terrestrial applications (diflufenzopyr, imazapic, and sulfometuron methyl). The aquatic herbicide a.i., diquat and fluridone, would be used for treatment of the water body. Therefore, exposure to a water body treated with diquat and fluridone is similar to a re-entry scenario evaluated for the terrestrial herbicide a.i. The exposure scenarios for both the inadvertently-sprayed and treated water bodies are the same. Incidental ingestion and dermal contact with water while swimming is evaluated for:

- Adult receptor - swimmer
- Child receptor - swimmer

In addition, the Native American child and adult receptors are evaluated for dermal contact while swimming and ingesting drinking water. While incidental ingestion of water could occur for this receptor while swimming, incidental ingestion was not evaluated separately because it results in minimal exposure compared to drinking water exposure.

An angler could fish in and ingest fish from a directly sprayed water body. Therefore, fish ingestion is evaluated for:

- Adult receptor - angler and Native American
- Child receptor - Native American

In addition, hikers, berry pickers, anglers, and Native American receptors could get part of their day's water for drinking from a directly sprayed water body. Occasional drinking water ingestion is evaluated for:

- Adult receptor - hiker/hunter, berry picker, angler, and Native American
- Child receptor - berry picker and Native American

4.3.2.2 Spills

Members of the public may be exposed to an herbicide a.i. present in water if a load of herbicide mixture is spilled or if a container of herbicide concentrate breaks open and spills into a pond. Under this scenario, it is assumed that a fully loaded truck or helicopter empties its contents into a pond while transporting herbicide to an application site. However, it is BLM policy that herbicides are mixed at the application site. Therefore, this scenario represents a conservative, worst-case scenario that is unlikely to occur.

To evaluate this scenario, it is assumed that a pond is subjected to a spill of 140 gallons of herbicide mix from a helicopter or 200 gallons of herbicide mix from a batch truck. These amounts are approximately the largest amounts that can be carried in helicopters or trucks, respectively, as used by the BLM. It is assumed that the pond size is ¼ acre and 1-meter deep, in accordance with the *Vegetation Treatments Programmatic Ecological Risk Assessment Protocol* (ENSR 2004).

The same receptors and exposure pathways listed above for the directly sprayed water body are evaluated for the water body that has received a direct spill.

4.3.3 Exposure Parameters for Public Receptors

Specific exposure parameters for each public receptor scenario are provided in Table 4-5. Exposure parameters are the same for routine-use and accidental scenarios. Various guidelines and databases, such as the USEPA's *EFH* (USEPA 1997a) and their draft paper "*Framework for Assessing Non-Occupational, Non-Dietary (Residential) Exposure to Pesticides*" (USEPA 1998b), were used to develop the exposure parameters. For each exposure scenario, the exposure parameters were used to calculate an exposure factor (EF), which is then used in the risk calculations presented in Appendix B. The use of the EF combines all the exposure parameters into one value in order to simplify the risk

calculations. The EF equations are presented in Section 5.2.2. All adult receptors are assumed to weigh 70 kg, and child receptors are assumed to weigh 15 kg (USEPA 1991).

4.3.3.1 Hiker/hunter

The hiker/hunter (adult) is assumed to be potentially exposed to herbicide a.i. via dermal contact with spray, dermal contact with sprayed foliage, and ingestion of drinking water from a sprayed pond. Table 4-5 presents the exposure parameters for these pathways.

The hiker/hunter is assumed to weigh 70 kg and ingest 2 liters of water while hiking (USEPA 1991). It is assumed that the hiker/hunter's lower legs, lower arms, and hands are exposed for potential herbicide a.i. contact. The 50th percentile SA of the lower legs, lower arms, and hands for men and women is 4,504 cm^2, and was calculated based on data in the *EFH* (USEPA 1997a). The 50th percentile values were used in accordance with USEPA guidance (USEPA 1989). The hiker/hunter is assumed to contact foliage for 2 hours per day. This is the 50th percentile value for time spent outdoors away from dwelling or vehicles (USEPA 1997a). The dermal Transfer Coefficient (Tc) is used to estimate the amount of herbicide a.i. that may be transferred from foliage to skin. A Tc value of 1,000 cm^2/hour was selected for the hiker/hunter. The Tc is the central tendency value for scouting grapes and sweet corn, and was recommended as a surrogate for scouting activity for berries (USEPA 2000b [referenced by USEPA 2002c]).

4.3.3.2 Berry Picker

The berry pickers (adult and child) are assumed to be potentially exposed to herbicide a.i. via dermal contact with spray, dermal contact with sprayed foliage, ingestion of drinking water from a sprayed pond, and ingestion of berries containing spray. Table 4-5 presents the exposure parameters for these pathways.

The adult berry picker is assumed ingest 2 liters of water while berry picking, and the child berry picker is assumed to ingest 1 liter of water while berry picking (USEPA 1991). It is assumed that the berry picker's lower legs, lower arms, and hands are exposed for potential herbicide a.i. contact. The 50th percentile SA of the lower legs, lower arms, and hands for adult men and women is 4,504 cm^2, and was calculated based on data in the *EFH* (USEPA 1997a). The 50th percentile SA of the lower legs, lower arms, and hands for children is 1,607 cm^2, and was calculated based on data in the *EFH* (USEPA 1997a). The adult and child berry pickers are assumed to contact foliage for 2 hours per day. A Tc value of 1,500 cm^2/hour was selected for the adult berry picker. This value is the high end Tc for harvesting blueberries (USEPA 2000b). A value of 300 cm^2/hour, based on the child to adult surface area ratio (SAR) was selected for the child berry picker (CalEPA 1996).

Berry ingestion rates (IRs) for this receptor were assumed to be the same as those used for the Native American adult and child. Harper, et al. (2002) list an IR of 320 g/day for an adult for above ground gathered terrestrial vegetation for the Native American Spokane tribe. Berries are likely to be a small fraction of this 320 g/day. However, since this rate was not subdivided into additional categories, it was conservatively assumed that the IR for berries is 320 g/day for an adult Native American. The use of this value for the berry picker receptor is conservative because the berry IR for the berry picker is likely to be lower than that for the Native American, who could have a higher rate of subsistence activities. For the child berry picker, the IR was scaled by BW (i.e., 320 g/day x 15 kg / 70 kg) to 69 g/day.

As shown in Table 4-5, the berry IR was converted to units of cm^2/day because of the equation used to evaluate this pathway (USEPA 2002c). Section 5.2.2.6 provides more details on this conversion.

4.3.3.3 Angler

The angler (adult) is assumed to be potentially exposed to herbicide a.i. via dermal contact with spray, dermal contact with sprayed foliage, ingestion of drinking water from a sprayed pond, and ingestion of fish from a sprayed pond. Table 4-5 presents the exposure parameters for these pathways.

The angler is assumed ingest 2 liters of water while fishing (USEPA 1991). It is assumed that the angler's lower legs, lower arms, and hands are exposed for potential herbicide a.i. contact. The 50th percentile SA of the lower legs, lower

arms, and hands for men and women is 4,504 cm^2, and was calculated based on data in the *EFH* (USEPA 1997a). The angler is assumed to contact foliage for 2 hours per day. A Tc value of 1,000 cm^2/hour was selected for the angler, similar to the value used for the hiker/hunter. The Tc is the central tendency value for scouting grapes and sweet corn, and was recommended as a surrogate for scouting activity for berries [USEPA 2000b (referenced by USEPA 2002c)]. The angler is assumed to ingest 63 grams of fish per day, which is the 95th percentile long-term fish IR listed in the *EFH* (USEPA 1997c) for the general population.

4.3.3.4 Swimmer

The swimmers (adult and child) are assumed to be potentially exposed to herbicide a.i. via dermal contact with and incidental ingestion of water from a sprayed pond. The USEPA (2001d) recommends an exposed SA of 18,000 cm^2 for an adult swimmer and 6,600 cm^2 for a child swimmer. It is assumed that 50 mL (0.05 L) of water are ingested from the pond while swimming for an hour (USEPA 1989).

4.3.3.5 Nearby Resident

The nearby residents (adult and child) are assumed to be potentially exposed to herbicide a.i. via dermal contact with spray, dermal contact with sprayed foliage, and ingestion of berries containing spray. It is assumed that the resident could contact foliage in their yard, as well as foliage areas outside the house. It is assumed that the resident gathers berries from bushes located outside the house. Table 4-5 presents the exposure parameters for these pathways.

It is assumed that the resident's lower legs, lower arms, and hands are exposed for potential herbicide a.i. contact. The 50th percentile SA of the lower legs, lower arms, and hands for adult men and women is 4,504 cm^2, and was calculated based on data in the *EFH* (USEPA 1997a). The 50th percentile SA of the lower legs, lower arms, and hands for children is 1,607 cm^2, and was calculated based on data in the *EFH* (USEPA 1997a). The adult and child resident are assumed to contact foliage for 2 hours per day. A Tc value of 14,500 cm^2/hour was selected for the adult resident, and 5,200 cm^2/hour was selected for the child resident (USEPA 2001k). These Tc values are higher than those used for the other receptors, and assumes that contact with herbicide a.i. in foliage could occur in the residents' yards (i.e., playing in the grass is an activity that could result in greater transfer than walking through the brush or woods).

Berry IRs for this receptor were assumed to be the same as those used for the Native American adult and child. The rates are 320 g/day for an adult and a scaled IR of 69 g/day for a child, and are based on rates of above ground gathered terrestrial vegetation for the Native American Spokane tribe (Harper et al. 2002). The berry IR was converted to units of cm^2/day because of the requirements of the equation used to evaluate this pathway (USEPA 2002c).

4.3.3.6 Native American

The Native American receptors (adult and child) are assumed to be potentially exposed to herbicide a.i. via dermal contact with spray, dermal contact with sprayed foliage, ingestion of drinking water from a sprayed pond, ingestion of berries containing spray, dermal contact with water in a sprayed pond, and ingestion of fish from a sprayed pond. Table 4-5 presents the exposure parameters for these pathways.

The adult Native American is assumed ingest 1 L of water per day (Harper et al. 2002) from the sprayed pond. According to Harper et al. (2002), a representative Spokane Tribe subsistence exposure scenario assumes that an adult consumes 4 L of water per day out of which 2 L/day are consumed from the home drinking water well, 1 L/day is consumed at the work site, and 1 L/day is consumed in a sweat lodge (where water is poured over hot rocks to create a steam bath). It is assumed that the 1 L/day from the work site could come from a sprayed pond. The child Native American is assumed to consume half the adult rate resulting in 0.5 L/day from a sprayed pond.

Harris and Harper (1997) and Harper et al. (2002) do not provide specific data regarding Native American body SA or BW. It is assumed that the Native American's lower legs, lower arms, and hands are exposed for potential herbicide a.i. contact. The 50th percentile SA of the lower legs, lower arms, and hands for adult men and women is 4,504 cm^2, and was calculated based on data in the *EFH* (USEPA 1997c). The 50th percentile SA of the lower legs, lower arms,

and hands for children is 1,607 cm^2, and was calculated based on data in the *EFH* (USEPA 1997a). The Native American receptors are assumed to contact foliage for 3 hours per day of subsistence activities (Harper et al. 2002). A Tc value of 1,500 cm^2/hour was selected for the adult. This value is the high end Tc for harvesting blueberries (USEPA 2000b). A value of 300 cm^2/hour, based on the child to adult SAR (CalEPA 1996) was selected for the child.

The USEPA (2001d) recommends an exposed SA of 18,000 cm^2 for an adult swimmer and 6,600 cm^2 for a child swimmer. Because no specific data are available regarding SA, these estimates have been used to evaluate the Native American child and adult in this HHRA. The ET for swimming is assumed to be 2.6 hours/day in accordance with Harris and Harper (1997) which gives a swimming exposure frequency of 2.6 hours/day for 70 days/year. Incidental ingestion during swimming is not evaluated for the Native American since it is assumed that the pond is also used as a source of drinking water, and any incidental ingestion during swimming is therefore included in the drinking water scenario.

The berry IR was developed from information provided in Harper et al. (2002), which lists an IR of 320 g/day for an adult for above ground gathered terrestrial vegetation for the Native American Spokane tribe. Berries are likely to be a small fraction of this 320 g/day. However, since this rate was not subdivided into additional categories, it was conservatively assumed that the IR for berries is 320 g/day for an adult Native American. For the child Native American, the IR was scaled by BW (i.e., 320 g/day x 15 kg / 70 kg) to 69 g/day (per CalEPA 1996).

The adult fish IR was assumed to be 885 g/day based on a high fish diet scenario discussed in Harper et al. (2002). The high fish diet consists primarily of fish, supplemented by big game, aquatic amphibian/crustacean/mollusks, small mammals, and upland game birds. This value is much higher than the 95th percentile fish IR of 170 g/day recommended in USEPA (1997a) for a Native American subsistence population. For the child Native American, the IR was scaled by BW (i.e., 885 g/day x 15 kg / 70 kg) to 190 g/day (per CalEPA 1996).

4.4 Calculation of Exposure Point Concentrations

Exposure points are located where potential receptors may contact herbicide a.i. The herbicide a.i. concentration in the environmental medium that receptors may contact must be estimated in order to determine the magnitude of potential exposure. The concentration at the point of contact is referred to as the EPC.

4.4.1 Occupational Exposures

It is assumed that workers could be exposed via dermal contact and inhalation through routine-use of herbicide a.i. and via an accidental spill to worker skin.

Routine Exposures

For the routine exposures, the exposure dose is calculated using the herbicide a.i. AR (in lb a.i./day) and the AT per day. This information is provided in Tables 4-1 and 4-2.

Accidental Exposures

To calculate exposures from an accidental spill to worker skin, the concentration of a.i. in the formulation (in pounds of a.i. per gallon of formulation) must be derived. These concentrations are provided or can be calculated from the information provided on the reference herbicide labels (Appendix A). Three of the herbicide a.i. evaluated in the risk assessment (diquat, fluridone, and imazapic) may be present in a concentrated liquid formulation. Fluridone and imazapic are also present in a dry formulation; however, for this evaluation it is assumed that the worker is exposed to the concentrated liquid formulation. For the worker spill scenario, it is assumed that the worker is exposed to the concentrated liquid, therefore, the pounds of a.i. per gallon listed on the labels are used for the calculation. For diquat, fluridone, and imazapic, the concentrated liquid concentrations are 2 pounds a.i./gallon, 4 pounds a.i./gallon, and 2 pounds a.i./gallon, respectively.

Diflufenzopyr + dicamba and sulfometuron methyl are in a dry form, and need to be mixed with water before application. The concentration of a.i. present in the application-ready formulation is calculated using maximum ARs (in pounds of a.i. per acre; Table 4-1) and the minimum spray rate (in gallons per acre, information provided by the BLM). The combination of maximum AR and minimum spray rate results in the most concentrated solution. The concentration is calculated using the following equation:

$$\text{Concentration (pounds a.i./gallon)} = \frac{\text{Application rate (pounds a.i./acre)}}{\text{Spray rate (gallons/acre)}}$$

The helicopter spray rate of 5 gallons/acre results in the most concentrated solution, therefore the helicopter spray rate is used in the calculation. The maximum ARs for diflufenzopyr, dicamba, and sulfometuron methyl of 0.1 pounds a.i./acre, 0.25 pounds a.i./acre, and 0.38 pounds a.i./acre, respectively, are divided by the spray rate (5 gallons/acre) resulting in concentrations of 0.02 pounds a.i./gallon, 0.05 pounds a.i./gallon, and 0.076 pounds a.i./gallon, respectively (shown in Table 4-6).

As indicated in Section 5.3 of this risk assessment, the accidental spill scenario for dicamba, diquat and fluridone resulted in unacceptable risks to occupational receptors. Because of the unlikely nature of the scenario (i.e., a spill of concentrated liquid directly to worker skin), EPCs were also calculated assuming a spill to worker skin after the herbicide is mixed at the maximum or typical AR using the equation listed above. Table 4-7 presents the additional EPCs for dicamba, diquat, and fluridone.

4.4.2 Public Exposures

It is assumed that the public could have routine exposures to herbicide a.i. present in spray drift that have deposited onto the receptor, foliage, ponds, and berries. It is also assumed that there could be accidental direct spray onto the receptor, foliage, pond, and berries, as well as a direct spill into the pond.

4.4.2.1 Routine Exposure Point Concentrations

Off-target spray drift refers to the amount of sprayed pesticide that does not come into contact with the target area, but rather drifts in the air and settles on an off-target area. The magnitude of potential human exposure to herbicide a.i. as a result of off-target spray drift and surface runoff of herbicide a.i. from the target application area was estimated from modeled terrestrial deposition rates (DRs) and water body concentrations. A hypothetical ¼ acre, 1-meter deep pond was assumed for these calculations. Off-target spray drift and resulting terrestrial DRs and waterbody concentrations were predicted using the computer model, AgDRIFT® (Spray Drift Task Force [SDTF] 2002). Surface runoff of herbicide a.i. from the target application area and resulting waterbody (hypothetical pond) concentrations were predicted using the computer model GLEAMS (Groundwater Loading Effects of Agricultural Management Systems).

AgDRIFT®

AgDRIFT® Version 2.0.05 (SDTF 2002) is a computer model that is a product of the Cooperative Research and Development Agreement between the USEPA's Office of Research and Development and the SDTF (a coalition of pesticide registrants). It is based on, and represents an enhancement of, its preceding computer program, AGDISP (Agricultural Dispersal Model), which was developed by the National Aeronautics and Space Administration (NASA), the U.S. Department of Agriculture Forest Service, and the U.S. Army. AgDRIFT® was developed for use in regulatory assessments of off-target drift associated with agricultural use of pesticides through aerial, ground, or orchard/airblast applications. AgDRIFT® is based upon the simple idea that pesticide or herbicide drift is primarily a function of application technique (e.g., droplet size and release height), environmental conditions, and physical properties of the spray solution and not of the a.i. itself. To implement this idea, the computational approach employed by AgDRIFT® is based on a simple method that has evolved over a period of more than 20 years and yields high correlation with field measurement datasets. AgDRIFT® was selected for use in this risk assessment because it allows for the simulation of a broad range of aerial and ground application practices and associated off-target spray

drift. Further, the cooperative development of AgDRIFT® by the USEPA and the SDTF and the associated use of AgDRIFT® in regulatory assessments of off-target pesticide drift reinforces its suitability to this particular application.

AgDRIFT® enables the user to take a tiered approach to the modeling of drift by allowing the user to choose between three tiers of increasingly complex evaluations of off-target drift and deposition. The basic difference between the three tiers (Tiers I, II, and III) is the amount of control users have in selecting model input variables. Also, Tier I supports the evaluation of aerial and ground application scenarios, whereas Tiers II and III support the evaluation of only aerial application scenarios (for agricultural and forestry applications). Tier I is based on a set of standard "Good Application Practices" and requires little knowledge of the actual application conditions or herbicide a.i. properties. Tier I allows the user to modify a small number of model variables. Tiers II and III are based on the same set of "Good Application Practices" as Tier I. However, to implement either Tier II or III the user must have a progressively greater knowledge of the specific conditions under which herbicides will be applied. Tiers II and III allow the user to modify a progressively larger set of variables to make the scenario evaluated representative of the conditions under which herbicides will be applied.

Tier I was used in this PEIS to evaluate off-target drift associated with ground application scenarios. Tier II was used to evaluate off-target drift associated with aerial application of herbicides to agricultural and forestry land types. The agricultural land type represents land having a relatively short vegetative canopy (e.g., non-forested land such as rangeland). The forestry land type represents land having a higher vegetative canopy (e.g., forested land). The Tier I ground application model does not allow the user to select between land types. It simply models drift from ground application in an agriculture-like setting. Both Tier I and Tier II of the AgDRIFT® model were utilized to evaluate off-target spray drift to a terrestrial area or waterbody (e.g., a hypothetical pond) located perpendicular to, and downwind of, the herbicide application area. The terrestrial area simply represents a point on the ground at a fixed distance downwind of the application area. AgDRIFT® calculates the DR (mg/cm^2) for the terrestrial location of interest. The hypothetical pond is intended to represent a non-flowing waterbody approximately ¼ acre in size and 1-meter deep. The concentration of the herbicide a.i. being modeled in pond water is generated in the AgDRIFT® model based on the assumption of instantaneous mixing throughout the waterbody. The implementation of the Tier I ground and Tier II aerial application model and the model input variables (including the variables specific to the application method and environmental setting and specific to the herbicide a.i. being evaluated) are discussed and presented in Appendix C.

GLEAMS

GLEAMS is a modified version of the Chemical Runoff Erosion Assessment Management System (CREAMS) model that was originally developed to evaluate non-point source pollution from agricultural field-size areas. One of the benefits of the GLEAMS model is the ability to estimate a wide range of potential herbicide a.i. exposure concentrations as a function of important site-specific parameters such as soil characteristics, annual precipitation, etc. The model simulates edge-of-field and bottom-of-root-zone loadings of water, sediment, pesticides (or herbicides), and plant nutrients from the complex climate-soil-management interactions. The GLEAMS model has evolved through several versions from its inception in 1984 to the present, and has been evaluated in numerous climatic and soil regions around the world. The model was selected for use in this investigation because of its widespread acceptance, its suitability to this particular application, and the previous use of the model to support similar risk assessments for the U.S. Forest Service (SERA 2001b).

In this application, the GLEAMS model was used to simulate the fate and transport of the three terrestrial herbicide a.i. considered in this HHRA from an area representing a typical BLM application area. The fate and transport of the three herbicide a.i. was simulated by GLEAMS using a precipitation record and three other model components intended to represent hydrology, erosion and pesticide movement:

- *Precipitation Record* – Rainfall distribution was described in the GLEAMS model using a daily hyetograph from Medford, Oregon from 1990 when a total of approximately 13.5 inches of precipitation was recorded. The GLEAMS model used the hyetograph from 1990 to describe the annual distribution of precipitation during the model simulations and eight different precipitation totals including 5, 10, 25, 50, 100, 150, 200, and 250

inches/year. By scaling the eight different hypothetical precipitation totals by the precipitation record measured during 1990, the daily rainfall totals were increased in the model, while the annual distribution of precipitation was retained.

- *Hydrology* – The hydrology component of the GLEAMS model simulates the movement of water through an agricultural system by considering the effects of precipitation on surface runoff and percolation through the unsaturated zone. Three soil types were simulated in this application including silt, sand, and clay. The simulated application area was a 10-acre square with a 5% slope, and the climate applied to the simulation was the measured annual average at Medford, Oregon.

- *Erosion* – The erosion component of GLEAMS simulates the movement of sediment over the land surface using the Universal Soil Loss Equation (USLE). Typical values were used to represent the soil erodibility factor and a Manning Roughness coefficient.

- *Pesticide* – The pesticide component of the GLEAMS model was used to simulate the movement of the herbicide a.i. diflufenzopyr, imazapic, and sulfometuron methyl (the three herbicide a.i. designated for terrestrial deposition) through the ecosystem by associating the herbicide a.i. with both water and sediment. Literature values describing water solubility, foliar half-life, partitioning, washoff, and soil half-life were used to facilitate the GLEAMS model calculations.

The GLEAMS model was used to simulate the fate and transport and eventual waterbody (e.g., pond) loading of each of the three terrestrial herbicide a.i. assuming they were each applied to a single application area within the vicinity of a hypothetical pond and using combinations of each of the eight precipitation rates and each of the three soil types.

Ambient water concentrations were calculated for a pond immediately adjacent to the application field using model predicted runoff and percolation rates, and the mass of herbicide a.i. associated with each of these exports. Statistical values of concentrations were calculated using an entire year of predicted results extracted once the model had reached a quasi-steady state. The GLEAMS model provides daily predictions of herbicide a.i. export rates, which were used to calculate ambient water concentrations in a pond, and the daily values were used to determine short-term (7 day), intermediate-term (30 day), and long-term (annual) surface water concentrations. These exposure durations correspond to the exposure durations used to evaluate the toxicology endpoint data in Section 3 (Table 3-1). Long-term concentrations were calculated as the annual daily average from the last year of the 10-year simulation. Intermediate-term concentrations were calculated as the maximum 30-day average from the last year of the 10-year simulation. Short-term concentrations were calculated as the maximum 7-day average from the last year of the 10-year simulation. While it is possible that public receptors use public lands under intermediate- and long-term time frames, it is unlikely that public receptors would be exposed to herbicides under the routine use scenario for more than a short-term exposure, which is defined as 1 day to 1 month (USEPA 2001h). Therefore, short-term concentrations are used to evaluate the public receptors under the routine use exposure scenario. An evaluation of the public receptors under an intermediate- and a long-term exposure scenario is included in the Uncertainty Analysis (Section 5.5).

Ambient herbicide a.i. concentrations were calculated for a ¼ acre, 1-meter deep pond by assuming a fixed pond volume and a daily-predicted inflow of herbicide a.i. and water to the pond. Herbicide a.i. and water exported from the application area displaced water and herbicide a.i. in the pond, and a volume-weighted concentration was calculated and updated on a daily basis. Because the pond has a fixed volume, the concentration resulting from an influx of runoff and percolation water replaces an equal volume of pond water. In addition to the effect of runoff and percolation water on the pond concentrations of herbicide a.i., natural decay processes were considered in the model.

Pond concentrations for 42 scenarios were calculated for each time frame (18 from varying soil type and precipitation totals and 24 from a sensitivity analysis where soil type and five other parameters were varied). The highest calculated pond concentrations were selected from all of the scenarios for each time frame in order to provide the most conservative pond concentrations as an input to the HHRA. The timeframes were selected to correlate with USEPA's short-term, intermediate-term, and long-term NOAELs (Section 3.1.2). A detailed discussion of the GLEAMS modeling approach is presented in Appendix D. The individual ecological risk assessment (ERA) reports developed

for each herbicide a.i. contain a description of herbicide a.i.-specific GLEAMS model inputs and present a summary of GLEAMS model results for each herbicide a.i.

Terrestrial Deposition Rates and Exposure Point Concentrations

The initial terrestrial DRs predicted using the AgDRIFT® Tier I ground application and Tier II aerial application models are presented in Table 4-8 and were used to evaluate the following potential human exposure pathways:

- Dermal contact with herbicide a.i. in spray drift
- Dermal contact with herbicide a.i. on foliage
- Ingestion of herbicide a.i. that has deposited on berries

Spray drift DRs were estimated for two application scenarios, aerial and ground. For the aerial scenario, AgDRIFT® evaluates two land types (agricultural and forestry) for estimation of DRs. As the agricultural land type represents land having a relatively short vegetative canopy, it was used to estimate spray drift DRs resulting from aerial applications over non-forested areas, while the forestry land type (representing land having a higher vegetative canopy) was used to estimate spray drift DRs resulting from aerial applications over forested areas. To encompass all possibilities, both sets of DRs were used to evaluate public receptor exposures. Deposition rates were also calculated separately for plane and helicopter applications. The primary difference between the airplane and helicopter application scenarios is the speed at which the aircraft traverse the application area; the higher the speed of the aircraft, the greater the off-site drift. If herbicides are applied aerially in a manner consistent with best practices, a helicopter will traverse the application area at lower speeds; resulting in lower off-site drift. The following four sets of aerial DRs (presented in Table 4-8) were calculated using Tier II of the model for each herbicide a.i.:

- Agricultural land type, airplane application
- Agricultural land type, helicopter application
- Forestry land type, airplane application
- Forestry land type, helicopter application

Off-target spray drift and the resulting terrestrial impacts from the aerial application scenarios were predicted at distances of 100, 300, and 900 ft downwind of the herbicide application area. The closest distance to the receptor (e.g., 100 ft downwind), was used as the basis for the HHRA.

For ground applications using Tier I of the model, estimation of spray drift DR is not dependent on land type. Therefore, under land type for ground applications, Table 4-8 indicates "NA" or not applicable, meaning that the DRs apply to any land type. Ground applications may be conducted using either a high boom (spray boom height set at 50 inches above the ground) or a low boom (spray boom height set at 20 inches above the ground), and DRs vary by the height of the boom (the higher the height of the spray boom, the greater the off-site drift). Therefore, there are two sets of ground DRs calculated and presented in Table 4-8 for each herbicide a.i.:

- Ground application, low boom
- Ground application, high boom

Off-target spray drift and the resulting terrestrial impacts from the ground application scenarios were predicted at distances of 25, 100, and 900 ft downwind of the herbicide application area. The closest distance to the receptor (e.g., 25 ft feet downwind) was used as the basis for the HHRA.

Pond Deposition Rates and Exposure Point Concentrations

The surface water (pond) herbicide a.i. concentrations predicted using AgDRIFT® represent short-lived concentrations due to off-target spray drift. It is likely that these predicted herbicide a.i. levels are flushed out of the

hypothetical pond within a few days. For the aquatic herbicide a.i., it is assumed that these herbicide a.i. are sprayed onto a target pond and the spray drift settles onto an adjacent pond that was not targeted for spraying.

The pond herbicide a.i. concentrations predicted using the GLEAMS model represent the potential impact of surface runoff of herbicide a.i. and assume a constant loading to the pond. Therefore, the GLEAMS concentrations represent potential longer-term concentrations in the pond. The processes of spray drift onto and surface runoff into a surface water body are not directly additive, since they may not occur over the same time frame. However, as a conservative approach, the hypothetical herbicide a.i. concentrations due to spray drift predicted using AgDRIFT® were used in calculating the short-, intermediate-, and long-term surface water EPCs for all six herbicide a.i. The short-, intermediate-, and long-term concentrations of terrestrial herbicide a.i. calculating using the GLEAMS model were added to the AgDRIFT® predictions for those herbicide a.i. Using the AgDRIFT® output for short-, intermediate-, and long-term time frames is a conservative approach since AgDRIFT® mainly represents short-lived concentrations. These combined concentrations are used to evaluate:

- Dermal contact with herbicide a.i. in water while swimming
- Ingestion of herbicide a.i. in water used as drinking water or while swimming
- Ingestion of herbicide a.i. that may bioconcentrate in the edible tissue of recreationally caught fish

The pond concentrations calculated using AgDRIFT® are presented in Table 4-9. As for the terrestrial DRs, pond concentrations were calculated for several land types and application scenarios:

- Agricultural land type, airplane application
- Agricultural land type, helicopter application
- Forestry land type, airplane application
- Forestry land type, helicopter application
- Ground application, low boom
- Ground application, high boom

Off-target spray drift and the resulting aquatic impacts were predicted at distances 100, 300, and 900 ft downwind of the aerial application areas and 25, 100, and 900 ft downwind of the ground application areas. Again, for the HHRA, the nearest distances to the receptor were used (e.g., 100 ft and 25 ft downwind for the aerial and ground applications, respectively).

The highest pond concentrations for the three terrestrial herbicide a.i. calculated using GLEAMS are presented in Table 4-10. Table 4-11 presents the calculation of the combined GLEAMS and AgDRIFT® pond concentrations for terrestrial herbicide a.i. The final selected estimated short-, intermediate-, and long-term surface water EPCs for all six herbicide a.i. are presented in Table 4-12.

4.4.2.2 Accidental Exposure Point Concentrations

Direct Spray

Accidental exposures involving direct spray are estimated using the herbicide a.i. ARs (in pounds of a.i. per acre) shown in Table 4-1. It is assumed that the herbicide a.i. is sprayed at the maximum AR directly onto the receptor, foliage, berries, or pond. Pond concentrations resulting from a direct spray event are presented in Table 4-13, assuming a ¼ acre pond, 1-meter deep. The equation used to calculate the pond concentration is as follows:

$$\text{Pond Concentration } (\text{mg/L}) = \frac{\text{App.Rate}(\text{lb a.i./acre}) * 453{,}600\,\text{mg/lb} * 35.31\,\text{ft}^3/\text{m}^3 * 0.001\,\text{m}^3/\text{L}}{43{,}530\,\text{ft}^2/\text{acre} * \text{pond depth}\,(\text{ft})}$$

Spill

It is assumed that a pond receives a spill of 140 gallons of herbicide mix from a helicopter or 200 gallons of spray mix from a batch truck. These amounts are approximately the largest amounts that can be carried in helicopters or trucks, respectively, as used by the BLM. Similar to the worker spill scenario, the concentration of a.i. in the formulation must be derived. It is assumed that the herbicide a.i. are present in application-ready concentrations as they are being transported. Therefore, for the herbicide a.i. that may be present in concentrated liquid form (diquat, fluridone, and imazapic), a diluted concentration is calculated. Diflufenzopyr + dicamba and sulfometuron methyl are in solid form, and the concentration of a.i. in the application-ready formulation is calculated.

Similar to the worker spill scenario, the following equation is used to calculate the concentration of a.i. present in the application-ready formulation:

$$\text{Concentration (pounds a.i./gallon)} = \frac{\text{Application rate (pounds a.i./acre)}}{\text{Spray rate (gallons/acre)}}$$

Two spray rates are used in the equation to represent spraying from helicopters and trucks. Based on information provided by the BLM, the lowest spray rate from a helicopter is 5 gallons/acre and from a truck is 25 gallons/acre. While a range of spray rates is possible, these spray rates represent the lower end of the range and thus result in higher concentrations. Maximum ARs (shown in Table 4-1) were used for each of the six herbicide active ingredients. Because diflufenzopyr + dicamba are not proposed for application via helicopter, spill concentrations are not calculated for the helicopter scenario for these active ingredients. The calculated concentrations for the helicopter and truck scenarios are shown in Table 4-14, assuming the pond is ¼ acre in size and 1-meter deep. The equation used to calculate the pond concentration is as follows:

$$\text{Pond Concentration (mg/L)} = \frac{\text{Gal spilled} * \text{lb a.i./gallon} * 453{,}600\,\text{mg/lb} * 35.31\,\text{ft}^3/\text{m}^3 * 0.001\,\text{m}^3/\text{L}}{43{,}530\,\text{ft}^2/\text{acre} * \text{pond size (acre)} * \text{pond depth (ft)}}$$

As indicated in Section 5.3 of this risk assessment, both the accidental truck and helicopter spill scenarios for diquat resulted in unacceptable risks to public receptors. To provide a more realistic estimate of risk, EPCs were also calculated assuming spills at the typical AR using the equation listed above. Table 4-15 presents the additional EPCs for diquat.

4.5 Chemical-specific Parameters

Several chemical-specific parameters are used in the calculation of exposure doses described in the next section. These include absorption factors, skin permeability factors, and bioconcentration factors (BCFs). Each parameter is described below.

4.5.1 Absorption Factors

Absorption factors are used in this HHRA when the endpoint used to select the NOAEL and the exposure in the environmental medium of interest differ. For example, absorption factors are used with the dermal NOAELs for dicamba, diquat, fluridone, and imazapic because oral studies were used to determine the dermal NOAELs. The derivation of these absorption factors is discussed in Section, 3.2.3 (diquat), Section 3.2.4 (fluridone), and Section 3.2.5 (imazapic). The absorption factors are presented in Table 4-16.

4.5.2 Skin Permeability Constants

The estimation of exposure doses resulting from incidental dermal contact with surface water requires the use of a dermal permeability constant (Kp) in units of centimeters per hour (cm/hr). This method assumes that the behavior of constituents dissolved in water is described by Fick's Law. In Fick's Law, the steady-state flux of the solute across the

skin ($mg/cm^2/hr$) equals the permeability constant (Kp, cm/hr) multiplied by the concentration difference of the solute across the membrane (mg/cm^3). This approach is discussed by the USEPA (USEPA 1989, 1992, 2001d). For the six herbicide a.i. evaluated in the risk assessment, Kps were calculated using an equation presented in the USEPA's Supplemental Guidance for Dermal Risk Assessment (USEPA 2001d). The equation, the parameters used in the equation, and the calculated Kp values are presented in Table 4-17.

4.5.3 Fish Bioconcentration Factors

To estimate concentrations of herbicide a.i. in fish tissue, a BCF is used to approximate the amount of herbicide a.i. that bioconcentrates from the water into the fish tissue. BCFs used in this risk assessment are presented in Table 4-18.

TABLE 4-1
Summary of Herbicide Use - Dicamba

Program	Application Information					Herbicide[1]		
				Acres Treated Per Hour		Dicamba Portion of Distinct®/Overdrive®		
	Scenario	Vehicle	Method	Typical	Max	Used (Y/N)?	Typical Rate (lb a.i./acre)	Max Rate (lb a.i./acre)
Rangeland	Aerial	Plane	Fixed wing	250	500	N	NA	NA
		Helicopter	Rotary	100	200	N	NA	NA
	Ground	Human	Backpack	0.2	0.4	Y	0.1875	0.25
			Horseback	0.75	1	Y	0.1875	0.25
		ATV	Spot	0.25	0.5	Y	0.1875	0.25
			Boom/broadcast	0.8	1.6	Y	0.1875	0.25
		Truck mount	Spot	0.38	1	Y	0.1875	0.25
			Boom/broadcast	1.5	2.25	Y	0.1875	0.25
Public Domain Forest Land	Aerial	Plane	Fixed wing	250	500	N	NA	NA
		Helicopter	Rotary	100	200	N	NA	NA
	Ground	Human	Backpack	0.2	0.4	N	NA	NA
			Horseback	0.75	1	N	NA	NA
		ATV	Spot	0.25	0.5	N	NA	NA
			Boom/broadcast	0.8	1.6	N	NA	NA
		Truck mount	Spot	0.38	1	N	NA	NA
			Boom/broadcast	1.5	2.25	N	NA	NA
Energy and Mineral Sites	Aerial	Plane	Fixed wing	250	500	N	NA	NA
		Helicopter	Rotary	100	200	N	NA	NA
	Ground	Human	Backpack	0.2	0.4	Y	0.1875	0.25
			Horseback	0.75	1	Y	0.1875	0.25
		ATV	Spot	0.25	0.5	Y	0.1875	0.25
			Boom/broadcast	0.8	1.6	Y	0.1875	0.25
		Truck mount	Spot	0.38	1	Y	0.1875	0.25
			Boom/broadcast	1.5	2.25	Y	0.1875	0.25
Rights-of-way	Aerial	Plane	Fixed wing	250	500	N	NA	NA
		Helicopter	Rotary	100	200	N	NA	NA
	Ground	Human	Backpack	0.2	0.4	Y	0.1875	0.25
			Horseback	0.75	1	Y	0.1875	0.25
		ATV	Spot	0.25	0.5	Y	0.1875	0.25
			Boom/broadcast	0.8	1.6	Y	0.1875	0.25
		Truck mount	Spot	0.38	1	Y	0.1875	0.25
			Boom/broadcast	1.5	2.25	Y	0.1875	0.25

TABLE 4-1 (Cont.)
Summary of Herbicide Use - Dicamba

Program	Application Information					Herbicide[1]		
				Acres Treated Per Hour		Dicamba Portion of Distinct®/Overdrive®		
	Scenario	Vehicle	Method	Typical	Max	Used (Y/N)?	Typical Rate (lb a.i./acre)	Max Rate (lb a.i./acre)
Recreation and Cultural Sites	Aerial	Plane	Fixed wing	250	500	N	NA	NA
		Helicopter	Rotary	100	200	N	NA	NA
	Ground	Human	Backpack	0.2	0.4	Y	0.1875	0.25
			Horseback	0.75	1	Y	0.1875	0.25
		ATV	Spot	0.25	0.5	Y	0.1875	0.25
			Boom/broadcast	0.8	1.6	Y	0.1875	0.25
		Truck mount	Spot	0.38	1	Y	0.1875	0.25
			Boom/broadcast	1.5	2.25	Y	0.1875	0.25
Aquatic	Aerial	Plane	Fixed wing	250	500	N	NA	NA
		Helicopter	Rotary	100	200	N	NA	NA
	Ground	Human	Backpack	0.2	0.4	N	NA	NA
			Horseback	0.75	1	N	NA	NA
		ATV	Spot	0.25	0.5	N	NA	NA
			Boom/broadcast	0.8	1.6	N	NA	NA
		Truck mount	Spot	0.38	1	N	NA	NA
			Boom/broadcast	1.5	2.25	N	NA	NA
	Aquatic	Boat (diquat)	Spot	0.63	2	N	NA	NA
			Boom/broadcast	1.3	3	N	NA	NA
		Boat (fluridone)	Boom/broadcast (granular)	6.25	5.8	NA	NA	NA
			Boom/broadcast (liquid)	17.5	16.7	NA	NA	NA

[1] All data are based on a single application.
Typical = Typical application rate; and Max = Maximum application rate.
NA = Not applicable.

TABLE 4-1 (Cont.)
Summary of Herbicide Use - Diflufenzopyr

Program	Application Information					Herbicide[1]		
				Acres Treated Per Hour		Diflufenzopyr portion of Distinct®/Overdrive®		
	Scenario	Vehicle	Method	Typical	Max	Used (Y/N)?	Typical Rate (lb a.i./acre)	Max Rate (lb a.i./acre)
Rangeland	Aerial	Plane	Fixed wing	250	500	N	NA	NA
		Helicopter	Rotary	100	200	N	NA	NA
	Ground	Human	Backpack	0.2	0.4	Y	0.075	0.1
			Horseback	0.75	1	Y	0.075	0.1
		ATV	Spot	0.25	0.5	Y	0.075	0.1
			Boom/broadcast	0.8	1.6	Y	0.075	0.1
		Truck mount	Spot	0.38	1	Y	0.075	0.1
			Boom/broadcast	1.5	2.25	Y	0.075	0.1
Public Domain Forest Land	Aerial	Plane	Fixed wing	250	500	N	NA	NA
		Helicopter	Rotary	100	200	N	NA	NA
	Ground	Human	Backpack	0.2	0.4	N	NA	NA
			Horseback	0.75	1	N	NA	NA
		ATV	Spot	0.25	0.5	N	NA	NA
			Boom/broadcast	0.8	1.6	N	NA	NA
		Truck mount	Spot	0.38	1	N	NA	NA
			Boom/broadcast	1.5	2.25	N	NA	NA
Energy and Mineral Sites	Aerial	Plane	Fixed wing	250	500	N	NA	NA
		Helicopter	Rotary	100	200	N	NA	NA
	Ground	Human	Backpack	0.2	0.4	Y	0.075	0.1
			Horseback	0.75	1	Y	0.075	0.1
		ATV	Spot	0.25	0.5	Y	0.075	0.1
			Boom/broadcast	0.8	1.6	Y	0.075	0.1
		Truck mount	Spot	0.38	1	Y	0.075	0.1
			Boom/broadcast	1.5	2.25	Y	0.075	0.1
Rights-of-way	Aerial	Plane	Fixed wing	250	500	N	NA	NA
		Helicopter	Rotary	100	200	N	NA	NA
	Ground	Human	Backpack	0.2	0.4	Y	0.075	0.1
			Horseback	0.75	1	Y	0.075	0.1
		ATV	Spot	0.25	0.5	Y	0.075	0.1
			Boom/broadcast	0.8	1.6	Y	0.075	0.1
		Truck mount	Spot	0.38	1	Y	0.075	0.1
			Boom/broadcast	1.5	2.25	Y	0.075	0.1

TABLE 4-1 (Cont.)
Summary of Herbicide Use - Diflufenzopyr

Program	Application Information					Herbicide[1]		
				Acres Treated Per Hour		Diflufenzopyr portion of Distinct®/Overdrive®		
	Scenario	Vehicle	Method	Typical	Max	Used (Y/N)?	Typical Rate (lb a.i./acre)	Max Rate (lb a.i./acre)
Recreation and Cultural Sites	Aerial	Plane	Fixed wing	250	500	N	NA	NA
		Helicopter	Rotary	100	200	N	NA	NA
	Ground	Human	Backpack	0.2	0.4	Y	0.075	0.1
			Horseback	0.75	1	Y	0.075	0.1
		ATV	Spot	0.25	0.5	Y	0.075	0.1
			Boom/broadcast	0.8	1.6	Y	0.075	0.1
		Truck mount	Spot	0.38	1	Y	0.075	0.1
			Boom/broadcast	1.5	2.25	Y	0.075	0.1
Aquatic	Aerial	Plane	Fixed wing	250	500	N	NA	NA
		Helicopter	Rotary	100	200	N	NA	NA
	Ground	Human	Backpack	0.2	0.4	N	NA	NA
			Horseback	0.75	1	N	NA	NA
		ATV	Spot	0.25	0.5	N	NA	NA
			Boom/broadcast	0.8	1.6	N	NA	NA
		Truck mount	Spot	0.38	1	N	NA	NA
			Boom/broadcast	1.5	2.25	N	NA	NA
	Aquatic	Boat (diquat)	Spot	0.63	2	N	NA	NA
			Boom/broadcast	1.3	3	N	NA	NA
		Boat (fluridone)	Boom/broadcast (granular)	6.25	5.8	N	NA	NA
			Boom/broadcast (liquid)	17.5	16.7	N	NA	NA

[1] All data are based on a single application.
Typical = Typical application rate; and Max = Maximum application rate.
NA = Not applicable.

TABLE 4-1 (Cont.)
Summary of Herbicide Use - Diquat

Program	Application Information					Herbicide[1]		
				Acres Treated Per Hour		Diquat (Reward®)[2]		
	Scenario	Vehicle	Method	Typical	Max	Used (Y/N)?	Typical Rate (lb a.i./acre)	Max Rate (lb a.i./acre)
Rangeland	Aerial	Plane	Fixed wing	250	500	N	NA	NA
		Helicopter	Rotary	100	200	N	NA	NA
	Ground	Human	Backpack	0.2	0.4	N	NA	NA
			Horseback	0.75	1	N	NA	NA
		ATV	Spot	0.25	0.5	N	NA	NA
			Boom/broadcast	0.8	1.6	N	NA	NA
		Truck mount	Spot	0.38	1	N	NA	NA
			Boom/broadcast	1.5	2.25	N	NA	NA
Public Domain Forest Land	Aerial	Plane	Fixed wing	250	500	N	NA	NA
		Helicopter	Rotary	100	200	N	NA	NA
	Ground	Human	Backpack	0.2	0.4	N	NA	NA
			Horseback	0.75	1	N	NA	NA
		ATV	Spot	0.25	0.5	N	NA	NA
			Boom/broadcast	0.8	1.6	N	NA	NA
		Truck mount	Spot	0.38	1	N	NA	NA
			Boom/broadcast	1.5	2.25	N	NA	NA
Energy and Mineral Sites	Aerial	Plane	Fixed wing	250	500	N	NA	NA
		Helicopter	Rotary	100	200	N	NA	NA
	Ground	Human	Backpack	0.2	0.4	N	NA	NA
			Horseback	0.75	1	N	NA	NA
		ATV	Spot	0.25	0.5	N	NA	NA
			Boom/broadcast	0.8	1.6	N	NA	NA
		Truck mount	Spot	0.38	1	N	NA	NA
			Boom/broadcast	1.5	2.25	N	NA	NA
Rights-of-way	Aerial	Plane	Fixed wing	250	500	N	NA	NA
		Helicopter	Rotary	100	200	N	NA	NA
	Ground	Human	Backpack	0.2	0.4	N	NA	NA
			Horseback	0.75	1	N	NA	NA
		ATV	Spot	0.25	0.5	N	NA	NA
			Boom/broadcast	0.8	1.6	N	NA	NA
		Truck mount	Spot	0.38	1	N	NA	NA
			Boom/broadcast	1.5	2.25	N	NA	NA

TABLE 4-1 (Cont.)
Summary of Herbicide Use - Diquat

Program	Application Information					Herbicide[1]		
				Acres Treated Per Hour		Diquat (Reward®)[2]		
	Scenario	Vehicle	Method	Typical	Max	Used (Y/N)?	Typical Rate (lb a.i./acre)	Max Rate (lb a.i./acre)
Recreation and Cultural Sites	Aerial	Plane	Fixed wing	250	500	N	NA	NA
		Helicopter	Rotary	100	200	N	NA	NA
	Ground	Human	Backpack	0.2	0.4	N	NA	NA
			Horseback	0.75	1	N	NA	NA
		ATV	Spot	0.25	0.5	N	NA	NA
			Boom/broadcast	0.8	1.6	N	NA	NA
		Truck mount	Spot	0.38	1	N	NA	NA
			Boom/broadcast	1.5	2.25	N	NA	NA
Aquatic	Aerial	Plane	Fixed wing	250	500	Y	1	4
		Helicopter	Rotary	100	200	Y	1	4
	Ground	Human	Backpack	0.2	0.4	Y	1	4
			Horseback	0.75	1	Y	1	4
		ATV	Spot	0.25	0.5	Y	1	4
			Boom/broadcast	0.8	1.6	Y	1	4
		Truck mount	Spot	0.38	1	Y	1	4
			Boom/broadcast	1.5	2.25	Y	1	4
	Aquatic	Boat (diquat)	Spot	0.63	2	Y	1	4
			Boom/broadcast	1.3	3	Y	1	4
		Boat (fluridone)	Boom/broadcast (granular)	6.25	5.8	N	NA	NA
			Boom/broadcast (liquid)	17.5	16.7	N	NA	NA

[1] All data are based on a single application.
[2] BLM specified typical and maximum application rates for four different water bodies: Ponds, Whole Lake/Reservoir, Partial Lakes/Reservoir, and Canals. The highest typical application rate (Pond) was selected for use as the typical rate and the highest maximum application rate (Partial Lake/Reservoir) was selected for use as the maximum application rate. Application rates are dependent on water depth, which is assumed to be 1 meter (3.3 feet).
Typical = Typical application rate; and Max = Maximum application rate.
NA = Not applicable.

TABLE 4-1 (Cont.)
Summary of Herbicide Use - Fluridone

Program	Application Information					Herbicide[1]		
				Acres Treated Per Hour		Fluridone (Sonar®)[2]		
	Scenario	Vehicle	Method	Typical	Max	Used (Y/N)?	Typical Rate (lb a.i./acre)	Max Rate (lb a.i./acre)
Rangeland	Aerial	Plane	Fixed wing	250	500	N	NA	NA
		Helicopter	Rotary	100	200	N	NA	NA
	Ground	Human	Backpack	0.2	0.4	N	NA	NA
			Horseback	0.75	1	N	NA	NA
		ATV	Spot	0.25	0.5	N	NA	NA
			Boom/broadcast	0.8	1.6	N	NA	NA
		Truck mount	Spot	0.38	1	N	NA	NA
			Boom/broadcast	1.5	2.25	N	NA	NA
Public Domain Forest Land	Aerial	Plane	Fixed wing	250	500	N	NA	NA
		Helicopter	Rotary	100	200	N	NA	NA
	Ground	Human	Backpack	0.2	0.4	N	NA	NA
			Horseback	0.75	1	N	NA	NA
		ATV	Spot	0.25	0.5	N	NA	NA
			Boom/broadcast	0.8	1.6	N	NA	NA
		Truck mount	Spot	0.38	1	N	NA	NA
			Boom/broadcast	1.5	2.25	N	NA	NA
Energy and Mineral Sites	Aerial	Plane	Fixed wing	250	500	N	NA	NA
		Helicopter	Rotary	100	200	N	NA	NA
	Ground	Human	Backpack	0.2	0.4	N	NA	NA
			Horseback	0.75	1	N	NA	NA
		ATV	Spot	0.25	0.5	N	NA	NA
			Boom/broadcast	0.8	1.6	N	NA	NA
		Truck mount	Spot	0.38	1	N	NA	NA
			Boom/broadcast	1.5	2.25	N	NA	NA
Rights-of-way	Aerial	Plane	Fixed wing	250	500	N	NA	NA
		Helicopter	Rotary	100	200	N	NA	NA
	Ground	Human	Backpack	0.2	0.4	N	NA	NA
			Horseback	0.75	1	N	NA	NA
		ATV	Spot	0.25	0.5	N	NA	NA
			Boom/broadcast	0.8	1.6	N	NA	NA
		Truck mount	Spot	0.38	1	N	NA	NA
			Boom/broadcast	1.5	2.25	N	NA	NA

TABLE 4-1 (Cont.)
Summary of Herbicide Use - Fluridone

Program	Application Information					Herbicide[1]		
				Acres Treated Per Hour		Fluridone (Sonar®)[2]		
	Scenario	Vehicle	Method	Typical	Max	Used (Y/N)?	Typical Rate (lb a.i./acre)	Max Rate (lb a.i./acre)
Recreation and Cultural Sites	Aerial	Plane	Fixed wing	250	500	N	NA	NA
		Helicopter	Rotary	100	200	N	NA	NA
	Ground	Human	Backpack	0.2	0.4	N	NA	NA
			Horseback	0.75	1	N	NA	NA
		ATV	Spot	0.25	0.5	N	NA	NA
			Boom/broadcast	0.8	1.6	N	NA	NA
		Truck mount	Spot	0.38	1	N	NA	NA
			Boom/broadcast	1.5	2.25	N	NA	NA
Aquatic	Aerial	Plane	Fixed wing	250	500	Y	0.41	1.3
		Helicopter	Rotary	100	200	Y	0.41	1.3
	Ground	Human	Backpack	0.2	0.4	Y	0.41	1.3
			Horseback	0.75	1	Y	0.41	1.3
		ATV	Spot	0.25	0.5	Y	0.41	1.3
			Boom/broadcast	0.8	1.6	Y	0.41	1.3
		Truck mount	Spot	0.38	1	Y	0.41	1.3
			Boom/broadcast	1.5	2.25	Y	0.41	1.3
	Aquatic	Boat (diquat)	Spot	0.63	2	N	NA	NA
			Boom/broadcast	1.3	3	N	NA	NA
		Boat (fluridone)	Boom/broadcast (granular)	6.25	5.8	Y	0.41	1.3
			Boom/broadcast (liquid)	17.5	16.7	Y	0.41	1.3

[1] All data are based on a single application.
[2] BLM specified typical and maximum application rates for four different water bodies: Ponds, Whole Lake/Reservoir, Partial Lakes/Reservoir, and Canals. The highest typical application rate (Pond) was selected for use as the typical rate and the highest maximum application rate (Partial Lake/Reservoir) was selected for use as the maximum application rate. Application rates are dependent on water depth, which is assumed to be 1 meter (3.3 feet).
Typical = Typical application rate; and Max = Maximum application rate.
NA = Not applicable.

TABLE 4-1 (Cont.)
Summary of Herbicide Use - Imazapic

Program	Application Information					Herbicide[1]		
				Acres Treated Per Hour		Imazapic (Plateau®)		
	Scenario	Vehicle	Method	Typical	Max	Used (Y/N)?	Typical Rate (lb a.i./acre)	Max Rate (lb a.i./acre)
Rangeland	Aerial	Plane	Fixed wing	250	500	Y	0.031	0.19
		Helicopter	Rotary	100	200	Y	0.031	0.19
	Ground	Human	Backpack	0.2	0.4	Y	0.031	0.19
			Horseback	0.75	1	Y	0.031	0.19
		ATV	Spot	0.25	0.5	Y	0.031	0.19
			Boom/broadcast	0.8	1.6	Y	0.031	0.19
		Truck mount	Spot	0.38	1	Y	0.031	0.19
			Boom/broadcast	1.5	2.25	Y	0.031	0.19
Public Domain Forest Land	Aerial	Plane	Fixed wing	250	500	Y	0.031	0.19
		Helicopter	Rotary	100	200	Y	0.031	0.19
	Ground	Human	Backpack	0.2	0.4	Y	0.031	0.19
			Horseback	0.75	1	Y	0.031	0.19
		ATV	Spot	0.25	0.5	Y	0.031	0.19
			Boom/broadcast	0.8	1.6	Y	0.031	0.19
		Truck mount	Spot	0.38	1	Y	0.031	0.19
			Boom/broadcast	1.5	2.25	Y	0.031	0.19
Energy and Mineral Sites	Aerial	Plane	Fixed wing	250	500	Y	0.031	0.19
		Helicopter	Rotary	100	200	Y	0.031	0.19
	Ground	Human	Backpack	0.2	0.4	Y	0.031	0.19
			Horseback	0.75	1	Y	0.031	0.19
		ATV	Spot	0.25	0.5	Y	0.031	0.19
			Boom/broadcast	0.8	1.6	Y	0.031	0.19
		Truck mount	Spot	0.38	1	Y	0.031	0.19
			Boom/broadcast	1.5	2.25	Y	0.031	0.19
Rights-of-way	Aerial	Plane	Fixed wing	250	500	Y	0.031	0.19
		Helicopter	Rotary	100	200	Y	0.031	0.19
	Ground	Human	Backpack	0.2	0.4	Y	0.031	0.19
			Horseback	0.75	1	Y	0.031	0.19
		ATV	Spot	0.25	0.5	Y	0.031	0.19
			Boom/broadcast	0.8	1.6	Y	0.031	0.19
		Truck mount	Spot	0.38	1	Y	0.031	0.19
			Boom/broadcast	1.5	2.25	Y	0.031	0.19

TABLE 4-1 (Cont.)
Summary of Herbicide Use - Imazapic

Program	Application Information					Herbicide[1]		
				Acres Treated Per Hour		Imazapic (Plateau®)		
	Scenario	Vehicle	Method	Typical	Max	Used (Y/N)?	Typical Rate (lb a.i./acre)	Max Rate (lb a.i./acre)
Recreation and Cultural Sites	Aerial	Plane	Fixed wing	250	500	Y	0.031	0.19
		Helicopter	Rotary	100	200	Y	0.031	0.19
	Ground	Human	Backpack	0.2	0.4	Y	0.031	0.19
			Horseback	0.75	1	Y	0.031	0.19
		ATV	Spot	0.25	0.5	Y	0.031	0.19
			Boom/broadcast	0.8	1.6	Y	0.031	0.19
		Truck mount	Spot	0.38	1	Y	0.031	0.19
			Boom/broadcast	1.5	2.25	Y	0.031	0.19
Aquatic	Aerial	Plane	Fixed wing	250	500	N	NA	NA
		Helicopter	Rotary	100	200	N	NA	NA
	Ground	Human	Backpack	0.2	0.4	N	NA	NA
			Horseback	0.75	1	N	NA	NA
		ATV	Spot	0.25	0.5	N	NA	NA
			Boom/broadcast	0.8	1.6	N	NA	NA
		Truck mount	Spot	0.38	1	N	NA	NA
			Boom/broadcast	1.5	2.25	N	NA	NA
	Aquatic	Boat (diquat)	Spot	0.63	2	N	NA	NA
			Boom/broadcast	1.3	3	N	NA	NA
		Boat (fluridone)	Boom/broadcast (granular)	6.25	5.8	N	NA	NA
			Boom/broadcast (liquid)	17.5	16.7	N	NA	NA

[1] All data are based on a single application.
Typical = Typical application rate; and Max = Maximum application rate.
NA = Not applicable.

TABLE 4-1 (Cont.)
Summary of Herbicide Use - Sulfometuron Methyl

Program	Application Information					Herbicide[1]		
				Acres Treated Per Hour		Sulfometuron Methyl (Oust®)		
	Scenario	Vehicle	Method	Typical	Max	Used (Y/N)?	Typical Rate (lb a.i./acre)	Max Rate (lb a.i./acre)
Rangeland	Aerial	Plane	Fixed wing	250	500	N	NA	NA
		Helicopter	Rotary	100	200	N	NA	NA
	Ground	Human	Backpack	0.2	0.4	N	NA	NA
			Horseback	0.75	1	N	NA	NA
		ATV	Spot	0.25	0.5	N	NA	NA
			Boom/broadcast	0.8	1.6	N	NA	NA
		Truck mount	Spot	0.38	1	N	NA	NA
			Boom/broadcast	1.5	2.25	N	NA	NA
Public Domain Forest Land	Aerial	Plane	Fixed wing	250	500	N	NA	NA
		Helicopter	Rotary	100	200	Y	0.14	0.38
	Ground	Human	Backpack	0.2	0.4	Y	0.14	0.38
			Horseback	0.75	1	Y	0.14	0.38
		ATV	Spot	0.25	0.5	Y	0.14	0.38
			Boom/broadcast	0.8	1.6	Y	0.14	0.38
		Truck mount	Spot	0.38	1	Y	0.14	0.38
			Boom/broadcast	1.5	2.25	Y	0.14	0.38
Energy and Mineral Sites	Aerial	Plane	Fixed wing	250	500	N	NA	NA
		Helicopter	Rotary	100	200	Y	0.14	0.38
	Ground	Human	Backpack	0.2	0.4	Y	0.14	0.38
			Horseback	0.75	1	Y	0.14	0.38
		ATV	Spot	0.25	0.5	Y	0.14	0.38
			Boom/broadcast	0.8	1.6	Y	0.14	0.38
		Truck mount	Spot	0.38	1	Y	0.14	0.38
			Boom/broadcast	1.5	2.25	Y	0.14	0.38
Rights-of-way	Aerial	Plane	Fixed wing	250	500	N	NA	NA
		Helicopter	Rotary	100	200	Y	0.14	0.38
	Ground	Human	Backpack	0.2	0.4	Y	0.14	0.38
			Horseback	0.75	1	Y	0.14	0.38
		ATV	Spot	0.25	0.5	Y	0.14	0.38
			Boom/broadcast	0.8	1.6	Y	0.14	0.38
		Truck mount	Spot	0.38	1	Y	0.14	0.38
			Boom/broadcast	1.5	2.25	Y	0.14	0.38

TABLE 4-1 (Cont.)
Summary of Herbicide Use - Sulfometuron Methyl

Program	Application Information					Herbicide[1]		
				Acres Treated Per Hour		Sulfometuron Methyl (Oust®)		
	Scenario	Vehicle	Method	Typical	Max	Used (Y/N)?	Typical Rate (lb a.i./acre)	Max Rate (lb a.i./acre)
Recreation and Cultural Sites	Aerial	Plane	Fixed wing	250	500	N	NA	NA
		Helicopter	Rotary	100	200	N	NA	NA
	Ground	Human	Backpack	0.2	0.4	Y	0.14	0.38
			Horseback	0.75	1	Y	0.14	0.38
		ATV	Spot	0.25	0.5	Y	0.14	0.38
			Boom/broadcast	0.8	1.6	Y	0.14	0.38
		Truck mount	Spot	0.38	1	Y	0.14	0.38
			Boom/broadcast	1.5	2.25	Y	0.14	0.38
Aquatic	Aerial	Plane	Fixed wing	250	500	N	NA	NA
		Helicopter	Rotary	100	200	N	NA	NA
	Ground	Human	Backpack	0.2	0.4	N	NA	NA
			Horseback	0.75	1	N	NA	NA
		ATV	Spot	0.25	0.5	N	NA	NA
			Boom/broadcast	0.8	1.6	N	NA	NA
		Truck mount	Spot	0.38	1	N	NA	NA
			Boom/broadcast	1.5	2.25	N	NA	NA
	Aquatic	Boat (diquat)	Spot	0.63	2	N	NA	NA
			Boom/broadcast	1.3	3	N	NA	NA
		Boat (fluridone)	Boom/broadcast (granular)	6.25	5.8	N	NA	NA
			Boom/broadcast (liquid)	17.5	16.7	N	NA	NA

[1] All data are based on a single application.
Typical = Typical application rate; and Max = Maximum application rate.
NA = Not applicable.

TABLE 4-2
Exposure Parameters for Occupational Receptors

Application Type (Scenario)	Application Vehicle	Application Method		Receptor	Exposure Parameters[1]						
					Hours Per Day		Days Per Year		Years of Exposure		Body Weight[2] (kg)
					Typical	Maximum	Typical	Maximum	Typical	Maximum	
Aerial	Plane	Fixed wing		Pilot	4	6	16	41	6	33	70
				Mixer/loader	4	6	16	41	6	33	70
	Helicopter	Rotary		Pilot	4	6	10	16	11	24	70
				Mixer/loader	4	6	10	16	11	24	70
Ground	Human	Backpack		Applicator/mixer/loader	3	6	22	30	6	25	70
		Horseback		Applicator	6	8	50	76	15	50	70
				Mixer/loader	6	8	50	76	15	50	70
				Applicator/mixer/loader[3]	6	8	50	76	15	50	70
	ATV	Spot		Applicator	5	9	50	76	6	24	70
				Mixer/loader	3	6	50	76	6	24	70
				Applicator/mixer/loader[3]	5	9	50	76	6	24	70
		Boom/broadcast		Applicator	5	9	39	60	6	24	70
				Mixer/loader	3	5	39	60	6	24	70
				Applicator/mixer/loader[3]	5	9	39	60	6	24	70
	Truck mount	Spot		Applicator	6	10	60	90	7	30	70
				Mixer/loader	4	8	60	90	7	30	70
				Applicator/mixer/loader[3]	6	10	60	90	7	30	70
		Boom/broadcast		Applicator	5	8	49	74	6	19	70
				Mixer/loader	3	6	49	74	6	19	70
				Applicator/mixer/loader[3]	5	8	49	74	6	19	70
Aquatic	Boat	Fluridone (Sonar®)	Boom/broadcast (granular)	Applicator/mixer/loader	4	6	12	19	6	23	70
			Boom/broadcast (liquid)	Applicator/mixer/loader	4	6	12	19	6	23	70
		Diquat (Reward®)	Spot	Applicator	4	6	12	19	6	23	70
				Mixer/loader	1	2	3	4	6	23	70
				Applicator/mixer/loader[3]	4	6	12	19	6	23	70
			Boom/broadcast	Applicator	4	6	12	19	6	23	70
				Mixer/loader	1	2	3	4	6	23	70
				Applicator/mixer/loader[3]	4	6	12	19	6	23	70

TABLE 4-2 (Cont.)
Exposure Parameters for Occupational Receptors

Application Type (Scenario)	Application Vehicle	Application Method		Receptor	Application Parameters			
					Acres Treated Per Hour[4]		Acres Treated Per Day[5]	
					Typical	Typical	Maximum	Typical
Aerial	Plane	Fixed wing		Pilot	4	250	500	1000
				Mixer/loader	4	250	500	1000
	Helicopter	Rotary		Pilot	4	100	200	400
				Mixer/loader	4	100	200	400
Ground	Human	Backpack		Applicator/mixer/loader	3	0.2	0.4	0.6
		Horseback		Applicator	6	0.75	1	4.5
				Mixer/loader	6	0.75	1	4.5
				Applicator/mixer/loader[3]	6	0.75	1	4.5
	ATV	Spot		Applicator	5	0.25	0.5	1.25
				Mixer/loader	3	0.25	0.5	0.75
				Applicator/mixer/loader[3]	5	0.25	0.5	1.25
		Boom/broadcast		Applicator	5	0.8	1.6	4
				Mixer/loader	3	0.8	1.6	2.4
				Applicator/mixer/loader[3]	5	0.8	1.6	4
	Truck Mount	Spot		Applicator	6	0.38	1	2.28
				Mixer/loader	4	0.38	1	1.52
				Applicator/mixer/loader[3]	6	0.38	1	2.28
		Boom/broadcast		Applicator	5	1.5	2.25	7.5
				Mixer/loader	3	1.5	2.25	4.5
				Applicator/mixer/loader[3]	5	1.5	2.25	7.5
Aquatic	Boat	Fluridone (Sonar®)	Boom/broadcast (granular)	Applicator/mixer/loader	6.25	5.8	25	35
			Boom/Broadcast (liquid)	Applicator/mixer/loader	17.5	16.7	70	100
		Diquat (Reward®)	Spot	Applicator	0.63	2	2.52	12
				Mixer/loader	0.63	2	0.63	4
				Applicator/mixer/loader[3]	0.63	2	2.52	12
			Boom/broadcast	Applicator	1.3	3	5.2	18
				Mixer/loader	1.3	3	1.3	6
				Applicator/mixer/loader[3]	1.3	3	5.2	18

TABLE 4-2 (Cont.)
Exposure Parameters for Occupational Receptors

Application Type (Scenario)	Application Vehicle	Application Method		Receptor	Unit Exposures[6]			
					Dermal[7]			Inhalation
					Gloves (mg/lb a.i.)		No Gloves (mg/lb a.i.)	Typical (mg/lb a.i.)
Aerial	Plane	Fixed wing		Pilot	0.0022		0.005	0.000068
				Mixer/loader	0.023		2.9	0.0012
	Helicopter	Rotary		Pilot	0.0022		0.005	0.000068
				Mixer/loader	0.023		2.9	0.0012
Ground	Human	Backpack		Applicator/mixer/loader	2.5		2.5	0.03
		Horseback		Applicator	0.39		1.3	0.0039
				Mixer/loader	0.023	[8]	2.9	0.0012
				Applicator/mixer/loader[3]	0.413		4.2	0.0051
	ATV	Spot		Applicator	0.39		1.3	0.0039
				Mixer/loader	0.023	[8]	2.9	0.0012
				Applicator/mixer/loader[3]	0.413		4.2	0.0051
		Boom/broadcast		Applicator	0.014		0.014	0.00074
				Mixer/loader	0.023		2.9	0.0012
				Applicator/mixer/loader[3]	0.037		2.914	0.00194
	Truck Mount	Spot		Applicator	0.39		1.3	0.0039
				Mixer/loader	0.023		2.9	0.0012
				Applicator/mixer/loader[3]	0.413		4.2	0.0051
		Boom/broadcast		Applicator	0.014		0.014	0.00074
				Mixer/loader	0.023		2.9	0.0012
				Applicator/mixer/loader[3]	0.037		2.914	0.00194
Aquatic	Boat	Fluridone (Sonar®)	Boom/broadcast (granular)	0.0069	0.0069		NA	0.0017
			Boom/Broadcast (liquid)	0.0069	0.0069		NA	0.0017
		Diquat (Reward®)	Spot	0.17	0.17	mg/hr[9]	NA	NA
				0.47	0.47	mg/hr[9]	NA	NA
				0.64	0.64	mg/hr[3]	NA	NA
			Boom/broadcast	0.17	0.17	mg/hr[9]	NA	NA
				0.47	0.47	mg/hr[9]	NA	NA
				0.64	0.64	mg/hr[9]	NA	NA

TABLE 4-2 (Cont.)
Exposure Parameters for Occupational Receptors

[1] With the exception of body weight, exposure parameters were provided by BLM personnel familiar with herbicide use in the vegetation treatment program.
[2] Source: USEPA (1991) *Standard Default Exposure Factors*.
[3] Sum of applicator and mixer loader unit exposures.
[4] Information provided by BLM personnel familiar with herbicide use in the vegetation treatment program. Also see Table 4-1.
[5] Acres treated per hour x hours per day.
[6] Unit exposure values from the USEPA *Pesticide Handlers Exposure Database* (PHED; USEPA 1998a). Also see Table 4-3.
[7] Assumes long-sleeved shirts and long pants are worn. As noted in text, some herbicide labels require the use of gloves and some do not.
[8] Unit exposure values not available. Therefore, unit exposures for truck mount used.
[9] Unit exposure values for hydrilla control-applicator and hydrilla control-mixer in the Diquat RED (USEPA 1995).
NA = Not applicable.

TABLE 4-3
Pesticide Handlers Exposure Database (PHED) Unit Exposures (UE)[1]

Dermal UE (mg/lb a.i.) Baseline[2]	Dermal UE (mg/lb a.i.) including gloves	Inhalation UE (ug/lb a.i.)	Comments
Mixing/Loading Liquids			
2.9	0.023	1.2	Recommended use for liquid formulations: mixing loading of aircraft and truck mounted equipment.
Pilot			
0.005	0.0022	0.068	The dermal values are based on pilots using enclosed cockpits.
			There are a few data points for rotary wing aircraft (3) showing similar values 0.0019 mg/a.i. handled. However, USEPA does not use this value.
Ground-boom			
0.014	0.014	0.74	Recommended use for any truck or ATV using a boom.
Rights-of-Way			
1.3	0.39	3.9	Consists of unrolling hose, using spray gun then rolling it back up. Recommend for ATV spot and horseback applicators.
Backpack			
No Data	2.5	30	Data consist of applicators using gloves.

[1] Table provided by USEPA (1998a). Values represent consensus UEs for these exposure scenarios as developed by the PHED task force.
[2] Assumes long sleeved shirts, long pants, and no gloves.

TABLE 4-4
Routine Use and Accidental Exposure Scenarios for Public Receptors

Receptor	Pathway	Scenario	Herbicide Concentration	Herbicide					
				Dicamba	Diflufenzopyr	Diquat	Fluridone	Imazapic	Sulfometuron Methyl
Hiker/Hunter									
	Dermal contact	Routine use	Spray drift	●	●	●	●	●	●
		Accidental	Direct spray	●	●	●	●	●	●
	Dermal contact with foliage	Routine use	Spray drift	●	●	●	●	●	●
		Accidental	Direct spray	●	●	●	●	●	●
	Ingestion of drinking water	Routine use	Spray drift	●	●	●	●	●	●
		Accidental	Direct spray and direct spill	●	●	●	●	●	●
Berry Picker - Child and Adult									
	Dermal contact	Routine use	Spray drift	●	●	●	●	●	●
		Accidental	Direct spray	●	●	●	●	●	●
	Dermal contact with foliage	Routine use	Spray drift	●	●	●	●	●	●
		Accidental	Direct spray	●	●	●	●	●	●
	Ingestion of drinking water	Routine use	Spray drift	●	●	●	●	●	●
		Accidental	Direct spray and direct spill	●	●	●	●	●	●
	Ingestion of berries	Routine use	Spray drift	●	●	●	●	●	●
		Accidental	Direct spray	●	●	●	●	●	●
Angler									
	Dermal contact	Routine use	Spray drift	●	●	●	●	●	●
		Accidental	Direct spray	●	●	●	●	●	●
	Dermal contact with foliage	Routine use	Spray drift	●	●	●	●	●	●
		Accidental	Direct spray	●	●	●	●	●	●
	Ingestion of drinking water	Routine use	Spray drift	●	●	●	●	●	●
		Accidental	Direct spray and direct spill	●	●	●	●	●	●
	Ingestion of fish	Routine use	Spray drift	●	●	●	●	●	●
		Accidental	Direct spray and direct spill	●	●	●	●	●	●

TABLE 4-4 (Cont.)
Routine Use and Accidental Exposure Scenarios for Public Receptors

Receptor	Pathway	Scenario	Herbicide Concentration	Herbicide					
				Dicamba	Diflufenzopyr	Diquat	Fluridone	Imazapic	Sulfometuron Methyl
Swimmer - Child and Adult									
	Dermal contact with water while swimming	Routine use	Spray drift	●	●	●	●	●	●
		Accidental	Direct spray/spill	●	●	●	●	●	●
	Ingestion of water while swimming	Routine use	Spray drift	●	●	●	●	●	●
		Accidental	Direct spray/spill	●	●	●	●	●	●
Nearby Resident - Child and Adult									
	Dermal contact	Routine use	Spray drift	●	●	●	●	●	●
		Accidental	Direct spray	●	●	●	●	●	●
	Dermal contact with foliage	Routine use	Spray drift	●	●	●	●	●	●
		Accidental	Direct spray	●	●	●	●	●	●
	Ingestion of berries	Routine use	Spray drift	●	●	●	●	●	●
		Accidental	Direct spray	●	●	●	●	●	●
Native American - Child and Adult									
	Dermal contact	Routine use	Spray drift	●	●	●	●	●	●
		Accidental	Direct spray	●	●	●	●	●	●
	Dermal contact with foliage	Routine use	Spray drift	●	●	●	●	●	●
		Accidental	Direct spray	●	●	●	●	●	●
	Dermal contact with water while swimming	Routine use	Spray drift	●	●	●	●	●	●
		Accidental	Direct spray/cpill	●	●	●	●	●	●
	Ingestion of water while swimming	Routine use	Spray drift	●	●	●	●	●	●
		Accidental	Direct spray/cpill	●	●	●	●	●	●
	Ingestion of berries	Routine use	Spray drift	●	●	●	●	●	●
		Accidental	Direct spray	●	●	●	●	●	●
	Ingestion of fish	Routine use	Spray drift	●	●	●	●	●	●
		Accidental	Direct spray/cpill	●	●	●	●	●	●

TABLE 4-5
Exposure Parameters for Public Receptors

Exposure Parameter	Units	Hiker/Hunter	Berry Picker – Child	Berry Picker – Adult	Angler	Swimmer – Child	Swimmer – Adult
Dermal Contact – Spray Drift (Routine/Worst Case) and Direct Spray (Accident)							
Skin exposed	cm^2/day	4,504[1,2]	1,607[1,2]	4,504[1,2]	4,504[1,2]	NA	NA
Body weight	kg	70[3]	15[3]	70[3]	70[3]	NA	NA
Exposure factor	cm^2/kg-day	64.34[4]	107.13[4]	64.34[4]	64.34[4]	NA	NA
Dermal Contact with Foliage							
Dermal transfer coefficient	cm^2/hour	1,000[5]	300[6]	1,500[7]	1,000[5]	NA	NA
Body weight	kg	70[3]	15[3]	70[3]	70[3]	NA	NA
Exposure time	hours/day	2[1,8]	2[1,8]	2[1,8]	2[1,8]	NA	NA
Exposure factor	cm^2/kg-day	28.57[9]	40.00[9]	42.86[9]	28.57[9]	NA	NA
Dermal Contact with Water While Swimming							
Skin exposed	cm^2	NA	NA	NA	NA	6,600[10]	18,000[10]
Exposure time	hours/day	NA	NA	NA	NA	1[11]	1[11]
Body weight	kg	NA	NA	NA	NA	15[3]	70[3]
Exposure factor	cm^2 hr/kg-day	NA	NA	NA	NA	440.00[12]	257.14[12]
Ingestion – Drinking Water and Swimming Water							
Ingestion rate	L/day	2[3,13]	1[3]	2[3]	2[3,13]	0.05[14]	0.05[14]
Body weight	kg	70[3]	15[3]	70[3]	70[3]	15[3]	70[3]
Exposure factor	cm^2 hr/kg-day	0.028571	0.066667	0.028571	0.028571	0.003333	0.000714
Ingestion – Berries							
Ingestion rate	mg/day	NA	69,000[15,16]	320,000[15,16]	NA	NA	NA
Ingestion rate (converted)	cm^2/day	NA	69[17]	320[17]	NA	NA	NA
Body weight	kg	NA	15[3]	70[3]	NA	NA	NA
Exposure factor	cm^2/kg-day	NA	4.60[18]	4.57[18]	NA	NA	NA
Ingestion – Fish (Recreational)							
Ingestion rate	mg/day	NA	NA	NA	630,000[1,19]	NA	NA
Body weight	kg	NA	NA	NA	70[3]	NA	NA
Exposure factor	mg/kg-day	NA	NA	NA	900.00[18]	NA	NA

TABLE 4-5 (Cont.)
Exposure Parameters for Public Receptors

Exposure Parameter	Units	Nearby Resident – Child	Nearby Resident – Adult	Native American – Child	Native American - Adult
Dermal Contact – Spray Drift (Routine/Worst Case) and Direct Spray (Accident)					
Skin exposed	cm^2/day	1,607[1,2]	4,504[1,2]	1,607[1,2]	4,504[1,2]
Body weight	kg	15[3]	70[3]	15[3]	70[3]
Exposure factor	cm^2/kg-day	107.13[4]	64.34[4]	107.13[4]	64.34[4]
Dermal Contact with Foliage					
Dermal transfer coefficient	cm^2/hour	5,200[20]	14,500[20]	300[6]	1,500[7]
Body weight	kg	15[3]	70[3]	15[3]	70[3]
Exposure time	hours/day	2[1,8]	2[1,8]	3[15]	3[15]
Exposure factor	cm^2/kg-day	693.33[9]	414.29[9]	60.00[9]	64.29[9]
Dermal Contact with Water While Swimming					
Skin exposed	cm^2	NA	NA	6,600[10]	18,000[21]
Exposure time	hours/day	NA	NA	2.6[22]	2.6[22]
Body weight	kg	NA	NA	15[3]	70[3]
Exposure factor	cm^2 hr/kg-day	NA	NA	1,144.00[12]	668.57[12]
Ingestion – Drinking Water and Swimming Water					
Ingestion rate	L/day	NA	NA	0.5[15,23]	1[15,23]
Body weight	kg	NA	NA	15[3]	70[3]
Exposure factor	cm^2 hr/kg-day	NA	NA	0.033333[18]	0.014286[18]
Ingestion – Berries					
Ingestion rate	mg/day	69,000[15,16]	320,000[15,16]	69,000[15,16]	320,000[15,16]
Ingestion rate (converted)	cm^2/day	69[17]	320[17]	69[17]	320[17]
Body weight	kg	15[3]	70[3]	15[3]	70[3]
Exposure factor	cm^2/kg-day	4.60[18]	4.57[18]	4.60[18]	4.57[18]
Ingestion – Fish (Recreational)					
Ingestion rate	mg/day	NA	NA	190,000[15,24]	885,000[15,24]
Body weight	kg	NA	NA	15[3]	70[3]
Exposure factor	mg/kg-day	NA	NA	12,666.67[18]	12,642.86[18]

TABLE 4-5 (Cont.)
Exposure Parameters for Public Receptors

[1] USEPA (1997a). *Exposure Factors Handbook*.
[2] 50th percentile value for surface area assuming lower legs, lower arms, and hands.
[3] USEPA (1991). *Standard Default Exposure Factors*.
[4] Skin exposed / body weight.
[5] Central tendency transfer coefficient for scouting table grapes (used for berry group in USEPA [2000b]).
[6] CalEPA, 1996. CalEPA transfer coefficient for carpets for adults. Children's transfer coefficient calculated based on ratio of child surface area to adult surface area.
[7] High end transfer coefficient (Tc) values for harvesting lowbush blueberries (400-1,500 cm^2/hr), cranberries (400 cm^2/hr), and strawberries (400-1,500 cm^2/hr).
[8] 50th percentile value for time spent outdoors away from dwelling or vehicles.
[9] Dermal transfer coefficient x exposure time / body weight.
[10] USEPA (2001d). *Risk Assessment Guidance for Superfund*. Volume 1: Human Health Evaluation Manual. Part E. September 2001. Exhibit 3-2.
[11] Recreational swimming is assumed to last for 1 hour
[12] (Skin exposed x exposure time) / body weight.
[13] USDI BLM (1991). *Vegetation Treatments on BLM Lands in Thirteen Western States*. Appendixes. Section E.4.
[14] USEPA (1989). *Risk Assessment Guidance for Superfund (RAGS).* Volume 1. Human Health Evaluation Manual (Part A).
[15] Harper et al. (2002). *The Spokane Tribe's Multipathway Subsistence Exposure Scenario and Screening Level RME*. Risk Analysis 22(3):513-526.
[16] The amount of ingested gathered terrestrial above ground vegetation is 320 g/day for adults (20% of 1600 g/day of total vegetation intake. The child ingestion rate is calculated as a ratio of the body weights (320 g/day x 15 kg/70 kg.
[17] Weight to surface area conversion for berry ingestion: Ingestion rate (mg/day) * 1 g/1000 mg * 2 cm2/g. Assume that 1/2 of berry has herbicide residue, so value is divided by 2.
[18] Ingestion rate/body weight.
[19] 95th percentile long term fish ingestion rate for the general population.
[20] Science Advisory Council for Exposure Policy #12. Recommended Revisions to the Standard Operating Procedures (SOPs) for Residential Exposure Assessments. February 22, 2001. Short term exposure values.
[21] USEPA (1989). *Risk Assessment Guidance for Superfund (RAGS).* Volume 1. Human Health Evaluation Manual (Part A).
[22] Harris and Harper (1997). *A Native American Exposure Scenario*. Risk Analysis 17(6):789-795.
[23] One liter of water is ingested away from home, which is assumed to be from the surface water source. The child ingestion rate is assumed to be 1/2 of the adult ingestion rate.
[24] The fish consumption rate for an adult for a high fish diet is 885 g/day. The child ingestion rate is calculated as a ratio of the body weights (885 g/day x 15 kg/70 kg).
NA = Not applicable. Receptor not assumed to be exposed to pesticides via this pathway.

TABLE 4-6
Calculation of Active Ingredient in a Spill to Worker Skin - Concentrated Solution

Herbicide Active Ingredient	Concentration of Active Ingredient in Spill[1] (lb a.i./gallon)	Concentration of Active Ingredient in Spill[2] (mg a.i./L)
Diflufenzopyr	0.02	2,402
Diquat	2	240,212
Fluridone	4	480,423
Imazapic	2	240,212
Sulfometuron methyl	0.076	9,128
Dicamba	0.05	6,005

[1] Obtained from label for diquat, fluridone, and imazapic. Calculated for diflufenzopyr, dicamba, and sulfometuron methyl, as follows:
Concentration in Spill = Maximum application rate (lb a.i./acre) / lowest spray rate (gallons/acre).
Maximum Application Rate = 0.1 lb a.i./acre for diflufenzopyr and 0.38 lb a.i./acre for sulfometuron methyl.
Lowest Spray Rate = 5 gallons/acre from a helicopter.
[2] Converted from (a): lb a.i./gallon * 4.54E5 mg/lb * 1 gallon/3.78 L

TABLE 4-7
Calculation of Active Ingredient in a Spill to Worker Skin - Mixed Solutions of Diquat, Fluridone, and Dicamba[1]

Herbicide Active Ingredient	Application Scenario	Application Rate[2] (lb a.i./acre)	Concentration of Active Ingredient in Mix[3] (lb a.i./gallon)	Concentration of Active Ingredient in Spill[4] (mg a.i./L)
Diquat	Typical	1	0.2	24,021
Fluridone	Typical	0.41	0.082	9,849
Diquat	Maximum	4	0.8	96,085
Fluridone	Maximum	1.3	0.26	31,228
Dicamba	Typical	0.1875	0.0375	4,504

[1] Aggregrate Risk Indices (ARI) for diquat and fluridone under the concentrated solution scenario are below one (See Section 5). Therefore, a mixed solution scenario is also evaluated for these two herbicides. The ARI for dicamba for a mixed solution assuming the maximum application rate is also below one (See Section 5). Therefore, a mixed solution assuming the typical application rate is also evaluated.
[2] See Table 4-1.
[3] Calculated as follows:
Concentration in Spill = Application rate (lb a.i./acre) / Lowest spray rate (gallons/acre).
Lowest Spray Rate = 5 gallons/acre from a helicopter.
[4] Converted from (a) : lb a.i./gallon * 4.54E5 mg/lb * 1 gallon/3.78 L.

TABLE 4-8
Spray Drift Deposition Rates[1]

AgDRIFT® Scenario	Land Type[2]	Equipment	Application Rate Scenario[3]	Imazapic (mg/cm^2)	Diflufenzopyr (mg/cm^2)	Diquat (mg/cm^2)	Fluridone (mg/cm^2)	Sulfometuron Methyl (mg/cm^2)	Dicamba (mg/cm^2)
Aerial	Agricultural	Plane	Typical	2.34E-05	NA[4]	1.10E-03	4.00E-04	NA[4]	NA[4]
Aerial	Agricultural	Helicopter	Typical	2.02E-05	NA[4]	1.00E-03	4.00E-04	1.00E-04	NA[4]
Aerial	Forestry	Plane	Typical	9.49E-05	NA[4]	NA[5]	NA[5]	NA[4]	NA[4]
Aerial	Forestry	Helicopter	Typical	6.44E-05	NA[4]	NA[5]	NA[5]	3.00E-04	NA[4]
Ground	NA[6]	Low boom[7]	Typical	4.41E-06	1.06E-05	1.00E-04	5.77E-05	1.99E-05	2.64E-05
Ground	NA[6]	High boom[7]	Typical	7.28E-06	1.75E-05	2.00E-04	9.54E-05	3.28E-05	4.36E-05
Aerial	Agricultural	Plane	Maximum	2.00E-04	NA[4]	5.10E-03	1.50E-03	NA[4]	NA[4]
Aerial	Agricultural	Helicopter	Maximum	1.00E-04	NA[4]	4.40E-03	1.30E-03	3.00E-04	NA[4]
Aerial	Forestry	Plane	Maximum	6.00E-04	NA[4]	NA[5]	NA[5]	NA[4]	NA[4]
Aerial	Forestry	Helicopter	Maximum	4.00E-04	NA[4]	NA[5]	NA[5]	8.00E-04	NA[4]
Ground	NA	Low boom[7]	Maximum	2.64E-05	1.41E-05	6.00E-04	2.00E-04	5.28E-05	3.52E-05
Ground	NA	High boom[7]	Maximum	4.36E-05	2.33E-05	9.00E-04	3.00E-04	8.73E-05	5.82E-05

[1] Deposition rates were calculated using AgDRIFT® software. Several deposition rates assuming different distances to receptors were calculated to support the ecological risk assessment. For the human health risk assessment, the deposition rates based on the closest distance to receptor (e.g., 100 feet for aerial applications and 25 feet for ground applications) were selected.
[2] Land type selected in AgDRIFT® to calculate deposition rates for aerial scenarios using the Tier II version of the model.
[3] See Table 4-1.
[4] Herbicide is not proposed for application via this method.
[5] Deposition on a pond is simulated using the agricultural land type option.
[6] Land type is not applicable to ground applications, which are evaluated using the Tier I version of the model.
[7] Boom/broadcast applications (see Table 4-1) can be conducted using low or high booms, which are evaluated separately here as boom height affects the deposition rate of off-site drift.
NA = Not applicable.

TABLE 4-9
Pond Concentrations Due to Spray Drift[1]

AgDRIFT® Scenario	Land Type[2]	Equipment	Application Rate Scenario[3]	Imazapic (mg/L)	Diflufenzopyr (mg/L)	Diquat (mg/L)	Fluridone (mg/L)	Sulfometuron Methyl (mg/L)	Dicamba (mg/L)
Aerial	Agricultural	Plane	Typical	1.56E-04	NA[4]	8.08E-03	2.94E-03	NA[4]	NA[4]
Aerial	Agricultural	Helicopter	Typical	1.32E-04	NA[4]	6.82E-03	2.50E-03	7.54E-04	NA[4]
Aerial	Forestry	Plane	Typical	6.79E-04	NA[4]	NA[5]	NA[5]	NA[4]	NA[4]
Aerial	Forestry	Helicopter	Typical	3.26E-04	NA[4]	NA[5]	NA[5]	1.69E-03	NA[4]
Ground	NA[6]	Low boom[7]	Typical	2.13E-05	5.11E-05	6.82E-04	2.79E-04	9.61E-05	1.28E-04
Ground	NA[6]	High boom[7]	Typical	3.43E-05	8.21E-05	1.09E-03	4.49E-04	1.54E-04	2.05E-04
Aerial	Agricultural	Plane	Maximum	1.15E-03	NA[4]	3.89E-02	1.13E-02	NA[4]	NA[4]
Aerial	Agricultural	Helicopter	Maximum	1.00E-03	NA[4]	3.23E-02	9.42E-03	2.32E-06	NA[4]
Aerial	Forestry	Plane	Maximum	4.54E-03	NA[4]	NA[5]	NA[5]	NA[4]	NA[4]
Aerial	Forestry	Helicopter	Maximum	1.99E-03	NA[4]	NA[5]	NA[5]	4.06E-03	NA[4]
Ground	NA	Low boom[7]	Maximum	1.28E-04	6.82E-05	2.73E-03	9.13E-04	2.56E-04	1.70E-04
Ground	NA	High boom[7]	Maximum	2.05E-04	1.09E-04	4.38E-03	1.47E-03	4.11E-04	2.74E-04

[1] Pond concentrations were calculated using AgDRIFT® software. Several deposition rates assuming different distances to receptor were calculated to support the ecological risk assessment. For the human health risk assessment, the deposition rates based on the closest distance to receptor (e.g., 100 feet for aerial applications and 25 feet for ground applications) were selected.
[2] Land type was selected in AgDRIFT® to calculate deposition rates for aerial scenarios using the Tier II version of the model.
[3] See Table 4-1.
[4] Herbicide application is not proposed for this method.
[5] Deposition onto a pond is simulated using the agricultural land type option.
[6] Land type is not applicable to ground applications, which are evaluated using the Tier I version of the model.
[7] Boom/broadcast applications (see Table 4-1) can be conducted using low or high booms, which are evaluated separately here as boom height affects the deposition rate of off-site drift.
NA = Not applicable.

TABLE 4-10
Pond Concentrations Due to Runoff[1]

Averaging Time	Application Scenario	Exposure Scenario	Imazapic (mg/L)	Diflufenzopyr (mg/L)	Sulfometuron Methyl (mg/L)	Dicamba (mg/L)
7-day	Typical	Short	1.39E-02	1.24E-02	5.89E-03	3.17E-02
7-day	Maximum	Short	1.85E-02	1.65E-02	7.85E-03	5.29E-02
30-day	Typical	Intermediate	7.01E-03	5.82E-03	3.51E-03	2.73E-02
30-day	Maximum	Intermediate	9.34E-03	7.76E-03	4.69E-03	4.55E-02
Annual	Typical	Long	8.32E-04	8.42E-04	1.66E-03	6.14E-03
Annual	Maximum	Long	5.10E-03	1.12E-03	4.51E-03	1.02E-02

[1] Pond concentrations were calculated using GLEAMS for a variety of scenarios (see text). The maximum pond concentration calculated for each averaging time (7-day, 30-day, and annual) was selected and presented here.

TABLE 4-11
Calculation of Pond Concentrations Due to Spray Drift and Runoff of Terrestrial Herbicides - Imazapic

AgDRIFT® Scenario	Land Type[1]	Equipment	Application Rate Scenario[2]	Exposure Duration	Imazapic		
					Spray Drift (mg/L)[3]	Runoff (mg/L)[4]	Total (mg/L)[5]
Aerial	Agricultural	Plane	Typical	Short	1.56E-04	1.39E-02	1.40E-02
Aerial	Agricultural	Helicopter	Typical	Short	1.32E-04	1.39E-02	1.40E-02
Aerial	Forestry	Plane	Typical	Short	6.79E-04	1.39E-02	1.45E-02
Aerial	Forestry	Helicopter	Typical	Short	3.26E-04	1.39E-02	1.42E-02
Ground	NA[6]	Low boom[7]	Typical	Short	2.13E-05	1.39E-02	1.39E-02
Ground	NA[6]	High boom[7]	Typical	Short	3.43E-05	1.39E-02	1.39E-02
Aerial	Agricultural	Plane	Maximum	Short	1.15E-03	1.85E-02	1.96E-02
Aerial	Agricultural	Helicopter	Maximum	Short	1.00E-03	1.85E-02	1.95E-02
Aerial	Forestry	Plane	Maximum	Short	4.54E-03	1.85E-02	2.30E-02
Aerial	Forestry	Helicopter	Maximum	Short	1.99E-03	1.85E-02	2.05E-02
Ground	NA	Low boom[7]	Maximum	Short	1.28E-04	1.85E-02	1.86E-02
Ground	NA	High boom[7]	Maximum	Short	2.05E-04	1.85E-02	1.87E-02
Aerial	Agricultural	Plane	Typical	Intermediate	1.56E-04	7.01E-03	7.16E-03
Aerial	Agricultural	Helicopter	Typical	Intermediate	1.32E-04	7.01E-03	7.14E-03
Aerial	Forestry	Plane	Typical	Intermediate	6.79E-04	7.01E-03	7.69E-03
Aerial	Forestry	Helicopter	Typical	Intermediate	3.26E-04	7.01E-03	7.33E-03
Ground	NA[6]	Low boom[7]	Typical	Intermediate	2.13E-05	7.01E-03	7.03E-03
Ground	NA[6]	High boom[7]	Typical	Intermediate	3.43E-05	7.01E-03	7.04E-03
Aerial	Agricultural	Plane	Maximum	Intermediate	1.15E-03	9.34E-03	1.05E-02
Aerial	Agricultural	Helicopter	Maximum	Intermediate	1.00E-03	9.34E-03	1.03E-02
Aerial	Forestry	Plane	Maximum	Intermediate	4.54E-03	9.34E-03	1.39E-02
Aerial	Forestry	Helicopter	Maximum	Intermediate	1.99E-03	9.34E-03	1.13E-02
Ground	NA	Low boom[7]	Maximum	Intermediate	1.28E-04	9.34E-03	9.47E-03
Ground	NA	High boom[7]	Maximum	Intermediate	2.05E-04	9.34E-03	9.55E-03
Aerial	Agricultural	Plane	Typical	Long	1.56E-04	8.32E-04	9.88E-04
Aerial	Agricultural	Helicopter	Typical	Long	1.32E-04	8.32E-04	9.64E-04
Aerial	Forestry	Plane	Typical	Long	6.79E-04	8.32E-04	1.51E-03
Aerial	Forestry	Helicopter	Typical	Long	3.26E-04	8.32E-04	1.16E-03
Ground	NA[6]	Low boom[7]	Typical	Long	2.13E-05	8.32E-04	8.54E-04
Ground	NA[6]	High boom[7]	Typical	Long	3.43E-05	8.32E-04	8.67E-04
Aerial	Agricultural	Plane	Maximum	Long	1.15E-03	5.10E-03	6.25E-03
Aerial	Agricultural	Helicopter	Maximum	Long	1.00E-03	5.10E-03	6.10E-03
Aerial	Forestry	Plane	Maximum	Long	4.54E-03	5.10E-03	9.64E-03
Aerial	Forestry	Helicopter	Maximum	Long	1.99E-03	5.10E-03	7.09E-03
Ground	NA[6]	Low boom[7]	Maximum	Long	1.28E-04	5.10E-03	5.23E-03
Ground	NA[6]	High boom[7]	Maximum	Long	2.05E-04	5.10E-03	5.31E-03

TABLE 4-11 (Cont.)
Calculation of Pond Concentrations Due to Spray Drift and Runoff of Terrestrial Herbicides - Diflufenzopyr

AgDRIFT® Scenario	Land Type[1]	Equipment	Application Rate Scenario[2]	Exposure Duration	Diflufenzopyr		
					Spray Drift (mg/L)[3]	Runoff (mg/L)[4]	Total (mg/L)[5]
Aerial	Agricultural	Plane	Typical	Short	NA[8]	NA[8]	NA[8]
Aerial	Agricultural	Helicopter	Typical	Short	NA[8]	NA[8]	NA[8]
Aerial	Forestry	Plane	Typical	Short	NA[8]	NA[8]	NA[8]
Aerial	Forestry	Helicopter	Typical	Short	NA[8]	NA[8]	NA[8]
Ground	NA[6]	Low boom[7]	Typical	Short	5.11E-05	1.24E-02	1.25E-02
Ground	NA[6]	High boom[7]	Typical	Short	8.21E-05	1.24E-02	1.25E-02
Aerial	Agricultural	Plane	Maximum	Short	NA[8]	NA[8]	NA[8]
Aerial	Agricultural	Helicopter	Maximum	Short	NA[8]	NA[8]	NA[8]
Aerial	Forestry	Plane	Maximum	Short	NA[8]	NA[8]	NA[8]
Aerial	Forestry	Helicopter	Maximum	Short	NA[8]	NA[8]	NA[8]
Ground	NA	Low boom[7]	Maximum	Short	6.82E-05	1.65E-02	1.66E-02
Ground	NA	High boom[7]	Maximum	Short	1.09E-04	1.65E-02	1.66E-02
Aerial	Agricultural	Plane	Typical	Intermediate	NA[8]	NA[8]	NA[8]
Aerial	Agricultural	Helicopter	Typical	Intermediate	NA[8]	NA[8]	NA[8]
Aerial	Forestry	Plane	Typical	Intermediate	NA[8]	NA[8]	NA[8]
Aerial	Forestry	Helicopter	Typical	Intermediate	NA[8]	NA[8]	NA[8]
Ground	NA[6]	Low boom[7]	Typical	Intermediate	5.11E-05	5.82E-03	5.87E-03
Ground	NA[6]	High boom[7]	Typical	Intermediate	8.21E-05	5.82E-03	5.90E-03
Aerial	Agricultural	Plane	Maximum	Intermediate	NA[8]	NA[8]	NA[8]
Aerial	Agricultural	Helicopter	Maximum	Intermediate	NA[8]	NA[8]	NA[8]
Aerial	Forestry	Plane	Maximum	Intermediate	NA[8]	NA[8]	NA[8]
Aerial	Forestry	Helicopter	Maximum	Intermediate	NA[8]	NA[8]	NA[8]
Ground	NA	Low boom[7]	Maximum	Intermediate	6.82E-05	7.76E-03	7.82E-03
Ground	NA	High boom[7]	Maximum	Intermediate	1.09E-04	7.76E-03	7.86E-03
Aerial	Agricultural	Plane	Typical	Long	NA[8]	NA[8]	NA[8]
Aerial	Agricultural	Helicopter	Typical	Long	NA[8]	NA[8]	NA[8]
Aerial	Forestry	Plane	Typical	Long	NA[8]	NA[8]	NA[8]
Aerial	Forestry	Helicopter	Typical	Long	NA[8]	NA[8]	NA[8]
Ground	NA[6]	Low boom[7]	Typical	Long	5.11E-05	8.42E-04	8.93E-04
Ground	NA[6]	High boom[7]	Typical	Long	8.21E-05	8.42E-04	9.24E-04
Aerial	Agricultural	Plane	Maximum	Long	NA[8]	NA[8]	NA[8]
Aerial	Agricultural	Helicopter	Maximum	Long	NA[8]	NA[8]	NA[8]

TABLE 4-11 (Cont.)
Calculation of Pond Concentrations Due to Spray Drift and Runoff of Terrestrial Herbicides – Sulfometuron Methyl

AgDRIFT® Scenario	Land Type[1]	Equipment	Application Rate Scenario[2]	Exposure Duration	Sulfometuron Methyl		
					Spray Drift (mg/L)[3]	Runoff (mg/L)[4]	Total (mg/L)[5]
Aerial	Agricultural	Plane	Typical	Short	NA[8]	NA[8]	NA[8]
Aerial	Agricultural	Helicopter	Typical	Short	7.54E-04	5.89E-03	6.64E-03
Aerial	Forestry	Plane	Typical	Short	NA[8]	NA[8]	NA[8]
Aerial	Forestry	Helicopter	Typical	Short	1.69E-03	5.89E-03	7.58E-03
Ground	NA[6]	Low boom[7]	Typical	Short	9.61E-05	5.89E-03	5.99E-03
Ground	NA[6]	High boom[7]	Typical	Short	1.54E-04	5.89E-03	6.04E-03
Aerial	Agricultural	Plane	Maximum	Short	NA[8]	NA[8]	NA[8]
Aerial	Agricultural	Helicopter	Maximum	Short	2.32E-06	7.85E-03	7.86E-03
Aerial	Forestry	Plane	Maximum	Short	NA[8]	NA[8]	NA[8]
Aerial	Forestry	Helicopter	Maximum	Short	4.06E-03	7.85E-03	1.19E-02
Ground	NA	Low boom[7]	Maximum	Short	2.56E-04	7.85E-03	8.11E-03
Ground	NA	High boom[7]	Maximum	Short	4.11E-04	7.85E-03	8.26E-03
Aerial	Agricultural	Plane	Typical	Intermediate	NA[8]	NA[8]	NA[8]
Aerial	Agricultural	Helicopter	Typical	Intermediate	7.54E-04	3.51E-03	4.27E-03
Aerial	Forestry	Plane	Typical	Intermediate	NA[8]	NA[8]	NA[8]
Aerial	Forestry	Helicopter	Typical	Intermediate	1.69E-03	3.51E-03	5.20E-03
Ground	NA[6]	Low boom[7]	Typical	Intermediate	9.61E-05	3.51E-03	3.61E-03
Ground	NA[6]	High boom[7]	Typical	Intermediate	1.54E-04	3.51E-03	3.67E-03
Aerial	Agricultural	Plane	Maximum	Intermediate	NA[8]	NA[8]	NA[8]
Aerial	Agricultural	Helicopter	Maximum	Intermediate	2.32E-06	4.69E-03	4.69E-03
Aerial	Forestry	Plane	Maximum	Intermediate	NA[8]	NA[8]	NA[8]
Aerial	Forestry	Helicopter	Maximum	Intermediate	4.06E-03	4.69E-03	8.75E-03
Ground	NA	Low boom[7]	Maximum	Intermediate	2.56E-04	4.69E-03	4.94E-03
Ground	NA	High boom[7]	Maximum	Intermediate	4.11E-04	4.69E-03	5.10E-03
Aerial	Agricultural	Plane	Typical	Long	NA[8]	NA[8]	NA[8]
Aerial	Agricultural	Helicopter	Typical	Long	7.54E-04	1.66E-03	2.42E-03
Aerial	Forestry	Plane	Typical	Long	NA[8]	NA[8]	NA[8]
Aerial	Forestry	Helicopter	Typical	Long	1.69E-03	1.66E-03	3.35E-03
Ground	NA[6]	Low boom[7]	Typical	Long	9.61E-05	1.66E-03	1.76E-03
Ground	NA[6]	High boom[7]	Typical	Long	1.54E-04	1.66E-03	1.82E-03
Aerial	Agricultural	Plane	Maximum	Long	NA[8]	NA[8]	NA[8]
Aerial	Agricultural	Helicopter	Maximum	Long	2.32E-06	4.51E-03	4.52E-03
Aerial	Forestry	Plane	Maximum	Long	NA[8]	NA[8]	NA[8]
Aerial	Forestry	Helicopter	Maximum	Long	4.06E-03	4.51E-03	8.57E-03
Ground	NA[6]	Low boom[7]	Maximum	Long	2.56E-04	4.51E-03	4.77E-03
Ground	NA[6]	High boom[7]	Maximum	Long	4.11E-04	4.51E-03	4.93E-03

TABLE 4-11 (Cont.)
Calculation of Pond Concentrations Due to Spray Drift and Runoff of Terrestrial Herbicides - Dicamba

AgDRIFT® Scenario	Land Type[1]	Equipment	Application Rate Scenario[2]	Exposure Duration	Dicamba		
					Spray Drift (mg/L)[3]	Runoff (mg/L)[4]	Total (mg/L)[5]
Aerial	Agricultural	Plane	Typical	Short	NA[8]	NA[8]	NA[8]
Aerial	Agricultural	Helicopter	Typical	Short	NA[8]	NA[8]	NA[8]
Aerial	Forestry	Plane	Typical	Short	NA[8]	NA[8]	NA[8]
Aerial	Forestry	Helicopter	Typical	Short	NA[8]	NA[8]	NA[8]
Ground	NA[6]	Low boom[7]	Typical	Short	1.28E-04	3.17E-02	3.19E-02
Ground	NA[6]	High boom[7]	Typical	Short	2.05E-04	3.17E-02	3.19E-02
Aerial	Agricultural	Plane	Maximum	Short	NA[8]	NA[8]	NA[8]
Aerial	Agricultural	Helicopter	Maximum	Short	NA[8]	NA[8]	NA[8]
Aerial	Forestry	Plane	Maximum	Short	NA[8]	NA[8]	NA[8]
Aerial	Forestry	Helicopter	Maximum	Short	NA[8]	NA[8]	NA[8]
Ground	NA	Low boom[7]	Maximum	Short	1.70E-04	5.29E-02	5.31E-02
Ground	NA	High boom[7]	Maximum	Short	2.74E-04	5.29E-02	5.32E-02
Aerial	Agricultural	Plane	Typical	Intermediate	NA[8]	NA[8]	NA[8]
Aerial	Agricultural	Helicopter	Typical	Intermediate	NA[8]	NA[8]	NA[8]
Aerial	Forestry	Plane	Typical	Intermediate	NA[8]	NA[8]	NA[8]
Aerial	Forestry	Helicopter	Typical	Intermediate	NA[8]	NA[8]	NA[8]
Ground	NA[6]	Low boom[7]	Typical	Intermediate	5.11E-05	5.82E-03	5.87E-03
Ground	NA[6]	High boom[7]	Typical	Intermediate	8.21E-05	5.82E-03	5.90E-03
Aerial	Agricultural	Plane	Maximum	Intermediate	NA[8]	NA[8]	NA[8]
Aerial	Agricultural	Helicopter	Maximum	Intermediate	NA[8]	NA[8]	NA[8]
Aerial	Forestry	Plane	Maximum	Intermediate	NA[8]	NA[8]	NA[8]
Aerial	Forestry	Helicopter	Maximum	Intermediate	NA[8]	NA[8]	NA[8]
Ground	NA	Low boom[7]	Maximum	Intermediate	6.82E-05	7.76E-03	7.82E-03
Ground	NA	High boom[7]	Maximum	Intermediate	1.09E-04	7.76E-03	7.86E-03
Aerial	Agricultural	Plane	Typical	Long	NA[8]	NA[8]	NA[8]
Aerial	Agricultural	Helicopter	Typical	Long	NA[8]	NA[8]	NA[8]
Aerial	Forestry	Plane	Typical	Long	NA[8]	NA[8]	NA[8]
Aerial	Forestry	Helicopter	Typical	Long	NA[8]	NA[8]	NA[8]
Ground	NA[6]	Low boom[7]	Typical	Long	1.28E-04	6.14E-03	6.26E-03
Ground	NA[6]	High boom[7]	Typical	Long	2.05E-04	6.14E-03	6.34E-03
Aerial	Agricultural	Plane	Maximum	Long	NA[8]	NA[8]	NA[8]
Aerial	Agricultural	Helicopter	Maximum	Long	NA[8]	NA[8]	NA[8]
Aerial	Forestry	Plane	Maximum	Long	NA[8]	NA[8]	NA[8]
Aerial	Forestry	Helicopter	Maximum	Long	NA[8]	NA[8]	NA[8]
Ground	NA[6]	Low boom[7]	Maximum	Long	1.70E-04	1.02E-02	1.04E-02
Ground	NA[6]	High boom[7]	Maximum	Long	2.74E-04	1.02E-02	1.05E-02

[1] Land type selected in AgDRIFT® to calculate aerial deposition rates using the Tier II version of the model.
[2] See Table 4-1.
[3] From Table 4-9.
[4] From Table 4-10.
[5] Sum of drift and runoff concentrations.
[6] Land type not applicable to ground applications, which are evaluated using the Tier I version of the model.
[7] Boom/broadcast applications (see Table 4-1) can be conducted using low or high booms, which are evaluated separately as boom height affects the deposition rate of off-site drift.
[8] Herbicide is not proposed for application via this method.
NA = Not applicable.

TABLE 4-12
Final Pond Exposure Point Concentrations

AgDRIFT® Scenario	Land Type[1]	Equipment	Application Rate Scenario[2]	Exposure Duration	Imazapic (mg/L)[3]	Diflufenzopyr (mg/L)[3]	Diquat (mg/L)[4]	Fluridone (mg/L)[4]	Sulfometuron Methyl (mg/L)[3]	Dicamba (mg/L)[3]
Aerial	Agricultural	Plane	Typical	Short	1.40E-02	NA[5]	8.08E-03	2.94E-03	NA[5]	NA[5]
Aerial	Agricultural	Helicopter	Typical	Short	1.40E-02	NA[5]	6.82E-03	2.50E-03	6.64E-03	NA[5]
Aerial	Forestry	Plane	Typical	Short	1.45E-02	NA[5]	NA[6]	NA[6]	NA[5]	NA[5]
Aerial	Forestry	Helicopter	Typical	Short	1.42E-02	NA[5]	NA[6]	NA[6]	7.58E-03	NA[5]
Ground	NA[7]	Low boom[8]	Typical	Short	1.39E-02	1.25E-02	6.82E-04	2.79E-04	5.99E-03	3.19E-02
Ground	NA[7]	High boom[8]	Typical	Short	1.39E-02	1.25E-02	1.09E-03	4.49E-04	6.04E-03	3.19E-02
Aerial	Agricultural	Plane	Maximum	Short	1.96E-02	NA[5]	3.89E-02	1.13E-02	NA[5]	NA[5]
Aerial	Agricultural	Helicopter	Maximum	Short	1.95E-02	NA[5]	3.23E-02	9.42E-03	7.86E-03	NA[5]
Aerial	Forestry	Plane	Maximum	Short	2.30E-02	NA[5]	NA[6]	NA[6]	NA[5]	NA[5]
Aerial	Forestry	Helicopter	Maximum	Short	2.05E-02	NA[5]	NA[6]	NA[6]	1.19E-02	NA[5]
Ground	NA	Low boom[8]	Maximum	Short	1.86E-02	1.66E-02	2.73E-03	9.13E-04	8.11E-03	5.31E-02
Ground	NA	High boom[8]	Maximum	Short	1.87E-02	1.66E-02	4.38E-03	1.47E-03	8.26E-03	5.32E-02
Aerial	Agricultural	Plane	Typical	Intermediate	7.16E-03	NA[5]	8.08E-03	2.94E-03	NA[5]	NA[5]
Aerial	Agricultural	Helicopter	Typical	Intermediate	7.14E-03	NA[5]	6.82E-03	2.50E-03	4.27E-03	NA[5]
Aerial	Forestry	Plane	Typical	Intermediate	7.69E-03	NA[5]	NA[6]	NA[6]	NA[5]	NA[5]
Aerial	Forestry	Helicopter	Typical	Intermediate	7.33E-03	NA[5]	NA[6]	NA[6]	5.20E-03	NA[5]
Ground	NA[7]	Low boom[8]	Typical	Intermediate	7.03E-03	5.87E-03	6.82E-04	2.79E-04	3.61E-03	2.74E-02
Ground	NA[7]	High boom[8]	Typical	Intermediate	7.04E-03	5.90E-03	1.09E-03	4.49E-04	3.67E-03	2.75E-02
Aerial	Agricultural	Plane	Maximum	Intermediate	1.05E-02	NA[5]	3.89E-02	1.13E-02	NA[5]	NA[5]
Aerial	Agricultural	Helicopter	Maximum	Intermediate	1.03E-02	NA[5]	3.23E-02	9.42E-03	4.69E-03	NA[5]
Aerial	Forestry	Plane	Maximum	Intermediate	1.39E-02	NA[5]	NA[6]	NA[6]	NA (h)	NA[5]
Aerial	Forestry	Helicopter	Maximum	Intermediate	1.13E-02	NA[5]	NA[6]	NA[6]	8.75E-03	NA[5]
Ground	NA	Low boom[8]	Maximum	Intermediate	9.47E-03	7.82E-03	2.73E-03	9.13E-04	4.94E-03	4.57E-02
Ground	NA	High boom[8]	Maximum	Intermediate	9.55E-03	7.86E-03	4.38E-03	1.47E-03	5.10E-03	4.58E-02
Aerial	Agricultural	Plane	Typical	Long	9.88E-04	NA[5]	8.08E-03	2.94E-03	NA[5]	NA[5]
Aerial	Agricultural	Helicopter	Typical	Long	9.64E-04	NA[5]	6.82E-03	2.50E-03	2.42E-03	NA[5]
Aerial	Forestry	Plane	Typical	Long	1.51E-03	NA[5]	NA[6]	NA[6]	NA[5]	NA[5]
Aerial	Forestry	Helicopter	Typical	Long	1.16E-03	NA[5]	NA[6]	NA[6]	3.35E-03	NA[5]
Ground	NA[7]	Low boom[8]	Typical	Long	8.54E-04	8.93E-04	6.82E-04	2.79E-04	1.76E-03	6.26E-03
Ground	NA[7]	High boom[8]	Typical	Long	8.67E-04	9.24E-04	1.09E-03	4.49E-04	1.82E-03	6.34E-03
Aerial	Agricultural	Plane	Maximum	Long	6.25E-03	NA[5]	3.89E-02	1.13E-02	NA[5]	NA[5]
Aerial	Agricultural	Helicopter	Maximum	Long	6.10E-03	NA[5]	3.23E-02	9.42E-03	4.52E-03	NA[5]

TABLE 4-12 (Cont.)
Final Pond Exposure Point Concentrations

AgDRIFT® Scenario	Land Type[1]	Equipment	Application Rate Scenario[2]	Exposure Duration	Imazapic (mg/L)[3]	Diflufenzopyr (mg/L)[3]	Diquat (mg/L)[4]	Fluridone (mg/L)[4]	Sulfometuron Methyl (mg/L)[3]	Dicamba (mg/L)[3]
Aerial	Forestry	Plane	Maximum	Long	9.64E-03	NA[5]	NA[6]	NA[6]	NA[5]	NA[5]
Aerial	Forestry	Helicopter	Maximum	Long	7.09E-03	NA[5]	NA[6]	NA[6]	8.57E-03	NA[5]
Ground	NA[7]	Low boom[8]	Maximum	Long	5.23E-03	1.19E-03	2.73E-03	9.13E-04	4.77E-03	1.04E-02
Ground	NA[7]	High boom[8]	Maximum	Long	5.31E-03	1.23E-03	4.38E-03	1.47E-03	4.93E-03	1.05E-02

[1] Land type selected in AgDRIFT® to calculate deposition rates for aerial scenarios using the Tier II version of the model.
[2] See Table 4-1.
[3] Terrestrial herbicide. Concentration is the sum of spray drift input (AgDRIFT®) and runoff (GLEAMS®). See Table 4-11 for calculation.
[4] Aquatic herbicide. Pond concentration is the spray drift input (AgDRIFT®; Table 4-9).
[5] Herbicide is not proposed for application via this method.
[6] Deposition on a pond is simulated using the agricultural land type option.
[8] Boom/broadcast applications (see Table 4-1) can be conducted using low or high booms, which are evaluated separately here as boom height affects the deposition rate of off-site drift.
[7] Land type is not applicable to ground applications, which are evaluated using the Tier I version of the model.
NA = Not applicable.

TABLE 4-13
Calculation of Pond Concentrations for Direct Spray to Pond for Maximum Application Rate Scenario

Herbicide Active Ingredient	Maximum Application Rate (lb a.i./acre)	Pond Depth (feet)	Unit Correction Factor (acre/feet^2)	Unit Correction Factor (mg/lb)	Unit Correction Factor (ft^3/m^3)	Unit Correction Factor (m^3/L)	Concentration of Active Ingredient in Waterbody (mg a.i./L)[1]
Diflufenzopyr[2]	0.1	3.28	43,530	454,000	35.31	0.001	0.011
Diquat[3]	4	3.28	43,530	454,000	35.31	0.001	0.449
Fluridone[3]	1.3	3.28	43,530	454,000	35.31	0.001	0.146
Imazapic[2]	0.19	3.28	43,530	454,000	35.31	0.001	0.021
Sulfometuron methyl[2]	0.38	3.28	43,530	454,000	35.31	0.001	0.043
Dicamba[2]	0.25	3.28	43,530	454,000	35.31	0.001	0.028

[1] Concentration (mg a.i./L) = application rate (lb a.i./acre) x 1/pond depth (ft) x acre/43,530 ft^2 x 453,600 mg/lb x 35.31 ft^3/m^3 x 0.001 m^3/L.
[2] Assumes that pond is accidentally sprayed.
[3] Assumes that pond is treated and receptor enters pond even though warning signs are posted.

TABLE 4-14
Calculation of Pond Concentrations for Spill to Pond (Maximum Application Rate Scenario)

Herbicide Active Ingredient	Spill Source	Amount Spilled (gallons)[1]	Maximum Application Rate (lb a.i./acre)[2]	Lowest Spray Rate (gal/acre)[3]	Concentration of Active Ingredient in Mix (lb a.i./gallon)[4]	Unit Correction Factor (mg/lb)	Unit Correction Factor (ft^3/m^3)	Unit Correction Factor (m^3/L)	Pond Size (acre)	Pond Depth (feet)	Unit Correction Factor (ft^2/acre)	Concentration of Active Ingredient in Spill (mg a.i./L)[5]
Diquat	Helicopter	140	4	5	0.8	454,000	35.31	0.001	0.25	3.28	43,530	50.30
Fluridone	Helicopter	140	1.3	5	0.26	454,000	35.31	0.001	0.25	3.28	43,530	16.35
Imazapic	Helicopter	140	0.19	5	0.038	454,000	35.31	0.001	0.25	3.28	43,530	2.39
Sulfometuron methyl	Helicopter	140	0.38	5	0.076	454,000	35.31	0.001	0.25	3.28	43,530	4.78
Diflufenzopyr	Truck	200	0.1	25	0.004	454,000	35.31	0.001	0.25	3.28	43,530	0.36
Diquat	Truck	200	4	25	0.16	454,000	35.31	0.001	0.25	3.28	43,530	14.37
Fluridone	Truck	200	1.3	25	0.052	454,000	35.31	0.001	0.25	3.28	43,530	4.67
Imazapic	Truck	200	0.19	25	0.0076	454,000	35.31	0.001	0.25	3.28	43,530	0.68
Sulfometuron methyl	Truck	200	0.38	25	0.0152	454,000	35.31	0.001	0.25	3.28	43,530	1.37
Dicamba	Truck	200	0.25	25	0.01	454,000	35.31	0.001	0.25	3.28	43,530	0.90

[1] These amounts are approximately the largest amounts that can be carried in helicopters (140 gallons) or trucks (200 gallons) as used by the BLM.
[2] See Table 4-1. Note that diflufenzopyr and dicamba are not applied via helicopter; therefore, spill concentrations for helicopter are not presented.
[3] These amounts are approximately the lowest spray rates of a helicopter (5 gallons/acre) and a truck (25 gallons/acre) as used by the BLM.
[4] Maximum application rate (lb a.i./acre) / lowest spray rate (gal/acre).
[5] Concentration (mg a.i./L) = (Spill amount (gallons) x concentration in mix (lb a.i./gallon) x 453,600 mg/lb x 35.31 ft^3/m^3 x 0.001 m^3/L) / 43,520 ft^2/acre x pond size (acres) x pond depth (feet).

TABLE 4-15
Calculation of Pond Concentrations for Spill to Pond for Typical Application Rate Scenario for Diquat[1]

Herbicide Active Ingredient	Spill Source	Amount Spilled (gallons)[2]	Typical Application Rate (lb a.i./acre)[3]	Lowest Spray Rate (gal/acre)[4]	Concentration of Active Ingredient in Mix (lb a.i./gallon)[5]	Unit Correction Factor (mg/lb)	Unit Correction Factor (ft^3/m^3)	Unit Correction Factor (m^3/L)	Pond Size (acre)	Pond Depth (feet)	Unit Correction Factor (ft^2/acre)	Concentration of Active Ingredient in Spill (mg a.i./L)[6]
Diquat	Helicopter	140	1	5	0.2	454,000	35.31	0.001	0.25	3.28	43,530	12.58
Diquat	Truck	200	1	25	0.04	454,000	35.31	0.001	0.25	3.28	43,530	3.59

[1] Aggregate risk index for diquat is less than 1; therefore, a typical application rate scenario is also evaluated. See Section 5.
[2] These amounts are approximately the largest amounts that can be carried in helicopters (140 gallons) or trucks (200 gallons) as used by BLM.
[3] See Table 4-1.
[4] These amounts are approximately the lowest spray rates of a helicopter (5 gallons/acre) and a truck (25 gallons/acre) as used by BLM.
[5] Maximum application rate (lb a.i./acre) / lowest spray rate (gal/acre).
[6] Concentration (mg a.i./L) = (Spill amount (gallons) x concentration in mix (lb a.i./gallon) x 453,600 mg/lb x 35.31 ft^3/m^3 x 0.001 m^3/L) / 43,520 ft^2/acre x pond depth (feet).

TABLE 4-16
Summary of Absorption Factors

Herbicide Active Ingredient	Dermal Absorption Factor	Inhalation Absorption Factor
Diflufenzopyr	NA	1
Diquat	0.041	1
Fluridone	0.4	1
Imazapic	0.5	1
Sulfometuron methyl	NA	1
Dicamba	0.15	1

NA = Not applicable.

TABLE 4-17
Summary of Skin Permeability Constants

Herbicide Active Ingredient	Molecular Weight (g/mol)	Log Kow (unitless)	Log Kp (unitless)[1]	Kp (cm/hr)
Diflufenzopyr	334.3[2,3]	1.09[4]	-3.98533	1.03E-04
Diquat	184.2[5]	-4.6[6,7]	-7.10962	7.77E-08
Fluridone	329.3[10]	1.87[8]	-3.40103	3.97E-04
Imazapic	275.3[2,9,10]	2.47[10]	-2.645691	2.26E-03
Sulfometuron methyl	364.4[6,11]	-0.509[6,7,12]	-5.30423	4.96E-06
Dicamba	221.04[13]	-0.67[6,14]	-4.544044	2.86E-05

[1] Log Kp = -2.80 + 0.66 log Kow - 0.0056 MW. Equation 3.8. Risk Assessment Guidance for Superfund, Volume I. Part E, Supplemental Guidance for Dermal Risk Assessment. September 2001.
[2] As acid.
[3] Hazardous Substances Databank (HSDB), a database of the National Library of Medicine's TOXNET system (http://toxnet.nlm.nih.gov).
[4] USEPA (1999b).
[5] Diquat cation.
[6] Tomlin (1994).
[7] Montgomery (1997).
[8] USEPA (1982); pH specified value.
[9] BASF (2001b).
[10] Howard and Meylan (1997).
[11] As methyl ester.
[12] At pH of 7.
[13] Howard (1991).
[14] Tomlin (1994).
Kow - Octanol-water partition coefficient.
Kp - Skin permeability constant.

TABLE 4-18
Summary of Bioconcentration Factors

Herbicide	Bioconcentration Factor (L/kg)	Source
Diflufenzopyr	3.16	National Library of Medicine (2003); calculated from Log Kow and regression equation.
Diquat	1.03	USEPA (1995)
Fluridone	3.01	USEPA (1982); West et al. (1983)
Imazapic	0.11	SERA (2001a)
Sulfometuron methyl	1	USEPA (1981)
Dicamba	28.78	National Library of Medicine (2002)

5.0 RISK CHARACTERIZATION

The purpose of the risk characterization is to provide estimates of the potential risk to human health from exposure to herbicide a.i. The results of the exposure assessment are combined with the results of the dose-response assessment to derive quantitative estimates of risk, or the probability of adverse health effects following assumed potential exposure to herbicide a.i. Since none of the six herbicide a.i. evaluated in this HHRA are considered to be potential carcinogens by the USEPA, the potential noncancer risk associated with the herbicide use scenarios is estimated.

The USEPA risk assessment guidance for pesticides (USEPA 2000a) provides different noncancer methods for evaluating food and non-food exposures. For food exposure, a percent (%) PAD method is used, and for non-food exposure, an MOE method is used. In order to estimate total exposure and risk from all exposure pathways, the USEPA has also developed an aggregate risk approach, which combines potential risks from various pathways expressed as MOEs and %PADs (USEPA 1999a, 2001b).

Section 5.1 discusses the overall approach for risk characterization, Section 5.2 presents equations for quantifying exposure and risk, Section 5.3 presents the results of the risk characterization, and Section 5.4 discusses uncertainties inherent in the risk assessment process.

5.1 Approach for Risk Characterization

The food (%PAD) and non-food (MOE) methods are summarized below, followed by the aggregate risk approach for combining these risk estimates.

5.1.1 Food (%PAD) Assessment

This assessment method evaluates exposures to a.i. residues in food and water. Toxicity is represented by a PAD and may be calculated for acute effects (acute PAD) or chronic effects (chronic PAD). A PAD is defined as an acute or chronic RfD divided by the FQPA SF (a value between 1 and 10), where appropriate (discussed in Section 3.0).

The noncancer risk estimate is the ratio of the exposure level (expressed as intake of the herbicide a.i. in mg/kg-day) to the PAD and is calculated using the following equation:

$$\%\text{PAD} = \frac{\text{Food Intake}(\text{mg}/\text{kg}-\text{day})}{\text{PAD}(\text{mg}/\text{kg}-\text{day})} \times 100$$

Exposures that are less than 100% of the PAD do not exceed the USEPA's level of concern.

As shown in Table 3-1, dicamba, diquat, and diflufenzopyr have acute PADs developed by the USEPA. Chronic PADs are available for dicamba, diflufenzopyr, diquat, imazapic, and sulfometuron methyl. The FQPA SF for each of these herbicide a.i. is 1; therefore, the PAD is equal to the RfD. For fluridone, the USEPA did not provide a PAD; therefore, the oral RfD provided in the USEPA's IRIS database (USEPA 2003c) was used to evaluate chronic oral exposure.

5.1.2 Non-Food (MOE) Assessment

This assessment method evaluates exposures via all non-food pathways (e.g., incidental ingestion, dermal, inhalation). The toxicity of the chemical is represented by a NOAEL identified from the scientific literature. The noncancer risk estimate is the ratio of the toxicity value to the exposure level and is calculated using the following general equation:

$$\text{Noncancer, MOE} = \frac{\text{NOAEL}(\text{mg/kg-day})}{\text{Exposure}(\text{mg/kg-day})}$$

Target MOEs are derived to account for the uncertainties associated with the NOAEL. Target MOEs are generally set at 100 to account for a factor of 10 for interspecies extrapolation and factor of 10 for intraspecies variability. Additional factors are applied when a LOAEL is used rather than a NOAEL. Calculated MOEs above the target MOE do not exceed the USEPA's level of concern. Calculated MOE values less than the target MOE indicate a potential concern for human health. As shown in Table 3-1, target MOEs are defined for each of the herbicide a.i. Target MOEs are 100 for all herbicide a.i., except for imazapic. The imazapic target MOE for long-term dermal and long-term inhalation exposures is 300, to account for the fact that the toxicity values are based on a LOAEL rather than a NOAEL. For all other exposure routes and time frames, the target MOE is 100.

5.1.3 Aggregate Risk Index

The %PAD method presents the risk result as the exposure estimate divided by the allowable exposure level (the PAD) and is expressed as a percentage of the total allowable exposure. Results less than or equal to 100% of the PAD are considered acceptable. However, for the MOE method, the identified NOAEL is divided by the estimated exposure, and is, therefore, the reverse of the %PAD method. For the MOE method, when the ratio is greater than the target MOE, the risk is considered to be negligible. Risk results using these different methods cannot be directly combined to account for cumulative risk from various exposure pathways. An aggregate approach, described below, is therefore used.

The USEPA's OPP (USEPA 1999a, USEPA 2001b) has developed the ARI approach, which combines potential risks from various pathways expressed as MOEs and %PADs. In this approach, it is important that only exposure pathways encompassing similar exposure durations be combined (i.e., acute exposures cannot be combined with chronic exposures). The ARI is an extension of the MOE concept. The ARI is compared against a target value of 1. Values greater than 1 do not exceed the USEPA's level of concern; values below 1 indicate a potential concern for human health.

The ARI method allows for direct comparisons between routes and between chemicals. The ARI method considers each route's potency when route-specific NOAELs that may have different target MOEs are used. [Note that USEPA (1999a) designates target MOEs as UFs. This report uses the term "target MOEs" for consistency with Section 3.0, Dose-response Assessment.] The %PAD calculated for oral exposures can also be incorporated into the ARI approach, using the following equation:

$$\text{ARI} = \frac{1}{\%\text{PAD}_O + \frac{\text{TM}_D}{\text{MOE}_D} + \frac{\text{TM}_I}{\text{MOE}_I}}$$

where:

ARI	=	Aggregate Risk Index
$\%PAD_O$	=	%PAD for oral exposure, expressed as a ratio (i.e., 80% = 0.8)
TM_D	=	Target MOE for dermal exposure
MOE_D	=	Site-specific MOE estimated for dermal exposure
TM_I	=	Target MOE for inhalation exposure
MOE_I	=	Site-specific MOE estimated for inhalation exposure

Not all herbicide a.i. include all of these toxicity endpoints. For example, some herbicide a.i. may not be toxic through the dermal route; therefore, the dermal MOE would not be included. The USEPA (1999a) provides the following example for an herbicide a.i. and receptor that has a dermal MOE of 100, dermal target MOE of 100, inhalation MOE of 1,000, inhalation target MOE of 300, and an oral %PAD of 80% (expressed as a ratio, 0.8):

$$ARI = \frac{1}{0.8_O + \frac{100_D}{100_D} + \frac{300_I}{1000_I}} = 0.48$$

In this example, the ARI (0.48) suggests a risk of concern because it is less than 1. It should be noted that, when listed separately, the oral PAD would be listed as % oral PAD (in this case, 80%). However, when included in this equation, the actual fraction (not the percentage) is listed.

Therefore, for this HHRA, the %PAD approach has been used to evaluate potential exposures to herbicide a.i. in food and water, the MOE approach to evaluate potential exposures to herbicide a.i. via non-food and incidental ingestion pathways, and the ARI approach to evaluate combined exposures.

5.2 Equations for Quantifying Potential Exposure and Risk

To estimate the potential risk to receptors from exposure to herbicide a.i., it is first necessary to estimate the potential exposure dose of each herbicide a.i. The exposure dose is estimated for each herbicide a.i. via each exposure pathway by which the receptor is assumed to be exposed. Exposure dose equations combine the estimates of herbicide a.i. concentration in the environmental medium of interest with assumptions regarding the type and magnitude of each receptor's potential exposure to provide a numerical estimate of the exposure dose. The exposure dose is defined as the amount of herbicide a.i. taken into the receptor and is expressed in units of milligrams of herbicide a.i. per kilogram of BW per day (mg/kg-day). Exposure doses are calculated separately for different time frames, such as short-term, intermediate-term, and long-term exposures.

The standardized equations for estimating a receptor's average daily dose are presented below. The following sections also show whether the dose is used with a NOAEL or PAD to estimate risks. NOAELs are used for non-dietary and incidental ingestion (such as ingestion of water while swimming) pathways to calculate MOEs. Potential risks from dietary exposure (such as drinking water, berry ingestion, and fish ingestion) are estimated using PADs. Table 5-1 indicates which NOAELs and/or PADs are used in the derivation of ARIs for each scenario.

5.2.1 Estimating Potential Occupational Exposures

Occupational exposures via dermal contact and inhalation are evaluated using the PHED UE values (as presented in Table 4-2). For the worker accidental exposure, it is assumed that the worker receives a direct spill and is exposed through dermal contact. The equations used are as follows (additional information is provided for parameters in the equations that have not already been defined).

5.2.1.1 Dermal Contact with Herbicide Active Ingredient

The following equations are used to evaluate occupational exposure through dermal contact:

$$Dose_{routine}(mg/kg-day) = \frac{AR\ (lb\ a.i./acre) * AT\ (acres/day) * UE_{derm}(mg\ a.i./lb\ a.i.) * DAF(unitless)}{BW\ (kg)}$$

and

$$\text{Dose}_{\text{accident}}\,(\text{mg/kg-day}) = \frac{\text{S(L/day)} * \text{AC(lb a.i./gallon)} * \text{CF}\left(\frac{\text{mg a.i./L}}{\text{lb a.i./gallon}}\right) * \text{SAR(unitless)} * \text{DAF(unitless)}}{\text{BW (kg)}}$$

where:

Parameter	Units	Definition
AR	lb a.i./acre	Herbicide active ingredient application rate (see Table 4-1)
AT	acres/day	Acres teated per day (see Table 4-1)
UE_{derm}	mg a.i./lb a.i.	Dermal unit exposure factor (see Table 4-2)
DAF	unitless	Dermal absorption factor (see Table 4-16)
S	L/day	Spill amount = 0.5 L of concentrate (Table 4-6)
AC	lb a.i./gallon	Concentration of active ingredient in concentrate (Table 4-6)
CF	1.2E+05 mg a.i./L / lb a.i./gallon	Conversion factor used to convert units of lb a.i. per gallon to units of mg a.i. per liter
SAR	unitless	Surface area ratio = Ratio of surface area exposed to total surface area, expressed as a percent (80% spilled to clothing, with a 30% penetration rate, and 20% spilled to bare skin) ((0.8*0.3)+0.2 = 0.44)
BW	kg	Body weight (see Table 4-2)

While most UEs are expressed in units of mg a.i./lb a.i., for aquatic application of diquat, the available UEs are in units of mg a.i./hr. The UEs to be used in the risk assessment are those for hydrilla control-applicator and hydrilla control-mixer listed in the Registration Eligibility Decision (RED) for diquat (USEPA 1995), which are expressed in terms of mg a.i. per hour. Daily exposure doses for diquat are calculated using the following equation:

$$\text{Dose}_{\text{routine}}\,(\text{mg/kg-day}) = \frac{\text{UE}_{\text{derm}}\,(\text{mg a.i./hr}) * \text{ET(hr/day)} * \text{DAF(unitless)}}{\text{BW (kg)}}$$

where:

Parameter	Units	Definition
ET	hours/day	Exposure time (see Table 4-2)
DAF	unitless	Dermal absorption factor (see Table 4-16)

MOEs are calculated as follows:

Dose	NOAEL Type	MOE Equation
Routine - Dermal	Dermal – short-term (ds)	$\frac{\text{NOAEL}_{\text{ds}}\,(\text{mg/kg-day})}{\text{Dose}_{\text{routine}}\,(\text{mg/kg-day})}$
	Dermal – intermediate-term (di)	$\frac{\text{NOAEL}_{\text{di}}\,(\text{mg/kg-day})}{\text{Dose}_{\text{routine}}\,(\text{mg/kg-day})}$
	Dermal – long-term (dl)	$\frac{\text{NOAEL}_{\text{dl}}\,(\text{mg/kg-day})}{\text{Dose}_{\text{routine}}\,(\text{mg/kg-day})}$
Accident	Dermal – short-term (ds)	$\frac{\text{NOAEL}_{\text{ds}}\,(\text{mg/kg-day})}{\text{Dose}_{\text{accident}}\,(\text{mg/kg-day})}$

Table 3-1 lists the short-term, intermediate-term and long-term dermal NOAELs for the six herbicide a.i. There are no dermal NOAELs for diflufenzopyr and sulfometuron methyl because neither have been shown to result in toxicity in

response to dermal exposure. Dermal NOAELs are available for the remaining herbicide a.i. Therefore, potential risks were not calculated for the herbicide a.i. and specific time frames that lacked dermal NOAELs.

5.2.1.2 Inhalation of Herbicide Active Ingredient

The following equation is used to evaluate occupational exposure through inhalation.

$$\text{Dose}_{\text{routine}}\,(\text{mg/kg-day}) = \frac{\text{AR}\,(\text{lb a.i./acre}) * \text{AT}\,(\text{acres/day}) * \text{UE}_{\text{inh}}\,(\text{mg a.i./lb a.i.}) * \text{IAF(unitless)}}{\text{BW}\,(\text{kg})}$$

where:

Parameter	Units	Definition
AR	lb a.i./acre	Herbicide active ingredient application rate (see Table 4-1)
AT	acres/day	Acres treated (see Table 4-1)
UE_{inh}	mg a.i./lb a.i.	Inhalation unit exposure from PHED database (see Table 4-2)
IAF	unitless	Inhalation absorption factor (see Table 4-16)
BW	kg	Body weight (see Table 4-2)

MOEs are calculated as follows:

Dose	NOAEL Type	MOE Equation
Routine	Inhalation – short-term (is)	$\frac{\text{NOAEL}_{\text{is}}\,(\text{mg/kg-day})}{\text{Dose}_{\text{routine}}\,(\text{mg/kg-day})}$
	Inhalation – intermediate-term (ii)	$\frac{\text{NOAEL}_{\text{ii}}\,(\text{mg/kg-day})}{\text{Dose}_{\text{routine}}\,(\text{mg/kg-day})}$
	Inhalation – long-term (il)	$\frac{\text{NOAEL}_{\text{il}}\,(\text{mg/kg-day})}{\text{Dose}_{\text{routine}}\,(\text{mg/kg-day})}$

Table 3-1 lists the short-term, intermediate-term, and long-term inhalation NOAELs for the six herbicide a.i. Inhalation NOAELs are available for all of the herbicide a.i. and time frames, which are reflected in the risk calculations.

5.2.2 Estimating Potential Exposure for Public Receptors

Exposure assumptions for public receptors are presented in Table 4-5. The equations used to calculate exposure doses are shown below. Additional information is provided for parameters in the equations that have not already been defined. As discussed in Section 3.0, dose-response values are available for short-, intermediate-, and long-term exposures. While it is possible that public receptors use public lands under intermediate- and long-term time frames, it is unlikely that public receptors would be exposed to herbicides under the routine use scenario for more than a short-term exposure, which is defined as 1 day to 1 month (USEPA 2001h). Therefore, short-term dose-response values are used to evaluate the public receptors under the routine use exposure scenario. To account for the unlikely possibility that public receptors could repeatedly enter areas that have been recently sprayed, the Uncertainty Analysis (see Section 5.5) includes an evaluation of the public receptors under an intermediate- and a long-term exposure scenario.

5.2.2.1 Dermal Contact with Herbicide Active Ingredient

The following equations are used to evaluate dermal contact with herbicide a.i. for public receptors through spray drift and accidental direct spray.

Spray Drift

$$\text{Dose}_{\text{routine}}\ (\text{mg/kg-day}) = \text{EF}_{\text{dp}}\ (\text{cm}^2/\text{kg-day}) * \text{DR}\ (\text{mg a.i./cm}^2) * \text{DAF}\ (\text{unitless})$$

Direct Spray

$$\text{Dose}_{\text{accident}}\ (\text{mg/kg-day}) = \text{EF}_{\text{dp}}\ (\text{cm}^2/\text{kg-day}) * \text{AR}\ (\text{lb a.i./acre}) * \text{CF}_1\ (\text{mg/lb}) * \text{CF}_2\ (\text{acre/cm}^2) * \text{DAF}\ (\text{unitless})$$

where:

$$\text{EF}_{\text{dp}}\ (\text{cm}^2/\text{kg-day}) = \frac{\text{SA}\ (\text{cm}^2/\text{day})}{\text{BW}\ (\text{kg})}$$

and where:

Parameter	Units	Definition
EF_{dp}	cm^2/kg-day	Exposure factor for dermal pathway (see Table 4-5)
DR	mg a.i./cm^2	Herbicide active ingredient deposition rate due to spray drift (see Table 4-8)
DAF	Unitless	Dermal absorption factor (Table 4-16)
AR	lb a.i./acre	Herbicide active ingredient application rate, direct spray, accidental scenarios (Table 4-1)
CF_1	4.54×10^5 mg/lb	Conversion factor used to convert pounds to mg
CF_2	2.47×10^{-8} acre/cm^2	Conversion factor used to convert acres to cm^2
SA	cm^2/day	Surface area of skin exposed (see Table 4-5)
BW	Kg	Body weight (see Table 4-5)

MOEs are calculated as follows:

Dose	NOAEL Type	MOE Equation
Routine	Dermal – short-term (ds)	$\frac{\text{NOAEL}_{\text{ds}}\ (\text{mg/kg-day})}{\text{Dose}_{\text{routine}}\ (\text{mg/kg-day})}$
Accident	Dermal – short-term (ds)	$\frac{\text{NOAEL}_{\text{ds}}\ (\text{mg/kg-day})}{\text{Dose}_{\text{accident}}\ (\text{mg/kg-day})}$

The short-term dermal NOAELs are presented in Table 3-1. Note that two of the herbicide a.i., diflufenzopyr and sulfometuron methyl, have been identified as not inducing dermal toxicity; therefore, dermal MOEs are not calculated for these herbicide a.i. For certain herbicide active igredients, the dose is calculated by including a DAF in the numerator of the equation to account for dermal absorption when the endpoint is selected from an oral study. As shown in Tables 3-1 and 4-16, the calculation of dermal doses for diquat, fluridone, and imazapic include DAFs of 4.1, 40, and 50%, since the dermal NOAELs are based on oral studies. For the other herbicide a.i., the USEPA has determined that dermal absorption is insignificant or that the dermal NOAELs are based on dermal studies and a DAF is not required.

5.2.2.2 Dermal Contact with Foliage

It is assumed that recreational and residential receptors could be exposed through dermal contact with herbicide a.i. present on foliage while hiking or berry picking. The equations for this pathway are based on information provided in two documents:

- *Draft Standard Operating Procedures (SOPs) for Residential Exposure Assessments* (USEPA 1997d)
- *Occupational and Residential Exposure and Risk for the Proposed Use of Metsulfuron-methyl on Sorghum* (USEPA 2002c).

Equations used to quantify this potential exposure are as follows:

$$\text{Dose}\ (\text{mg/kg-day}) = \text{EF}_{\text{df}}\ (\text{cm}^2/\text{kg-day}) * \text{DFR}\ (\text{mg/cm}^2) * \text{DAF}$$

where:

$$\text{EF}_{\text{df}}\ (\text{cm}^2/\text{kg-day}) = \frac{\text{T}_c\ (\text{cm}^2/\text{hr}) * \text{ET}\ (\text{hr/day})}{\text{BW}\ (\text{kg})}$$

$$\text{DFR}_{\text{routine}}\ (\text{mg/cm}^2) = \text{DR}\ (\text{mg a.i./cm}^2) * \text{F}\ (\text{unitless})$$

$$\text{DFR}_{\text{accident}}\ (\text{mg/cm}^2) = \text{F}\ (\text{unitless}) * \text{AR}\ (\text{lb a.i./acre}) * \text{CF}_1\ (\text{mg/lb}) * \text{CF}_2\ (\text{acre/cm}^2)$$

and where:

Parameter	Units	Definition
EF_{df}	cm^2/kg-day	Exposure factor for dermal foliage pathway (see Table 4-5)
DFR	mg/cm^2	Dislodgeable foliar residue (calculated)
DAF	unitless	Dermal absorption factor (see Table 4-16)
T_c	cm^2/hr	Transfer coefficient (see Table 4-5 and described below)
ET	hr/day	Exposure time (see Table 4-5)
BW	kg	Body weight (see Table 4-5)
DR	mg a.i./cm^2	Herbicide active ingredient deposition rate due to spray drift (see Table 4-8)
F	unitless	Fraction active ingredient retained on foliage (described below)
AR	lb a.i./acre	Herbicide active ingredient application rate direct spray, accidental scenario (see Table 4-1)
CF_1	4.54×10^5 mg/lb	Conversion factor used to convert pounds to mg
CF_2	2.47×10^{-8} acre/cm^2	Conversion factor used to convert acres to cm^2

MOEs are calculated as follows:

Dose	NOAEL Type	MOE Equation
Routine	Dermal – Short-term (ds)	$\frac{\text{NOAEL}_{\text{ds}}\ (\text{mg/kg-day})}{\text{Dose}_{\text{routine}}\ (\text{mg/kg-day})}$
Accident	Dermal – Short-term (ds)	$\frac{\text{NOAEL}_{\text{ds}}\ (\text{mg/kg-day})}{\text{Dose}_{\text{accident}}\ (\text{mg/kg-day})}$

The short-term dermal NOAELs are presented in Table 3-1. Note that two of the herbicide a.i., diflufenzopyr and sulfometuron methyl, have been identified as not inducing dermal toxicity, therefore, dermal MOEs are not calculated for these herbicide a.i. For certain herbicide a.i., the dose is calculated by including a DAF in the numerator of the equation to account for dermal absorption when the endpoint is selected from an oral study. As shown in Tables 3-1 and 4-16, the calculation of dermal doses for diquat, fluridone, and imazapic include DAFs of 4.1, 40, and 50%, since the dermal NOAELs are based on oral studies. For the other herbicide a.i., the USEPA has either determined that dermal absorption is insignificant, or the dermal NOAELs are based on dermal studies and a DAF factor is not required.

The dermal Tc is used to estimate the amount of herbicide a.i. that may be transferred from foliage to skin. Transfer coefficients for each receptor are shown in Table 4-5 and were selected as follows:

- Hiker/hunter and angler - 1,000 cm^2/hour (the central tendency Tc value for scouting grapes and also for scouting sweet corn, and recommended as a surrogate for scouting activity for berries) from USEPA 2000b (referenced by USEPA 2002c)
- Adult berry picker - 1,500 cm^2/hour (the high end blueberry value) from USEPA 2000b (referenced by USEPA 2002c)
- Child berry picker - 300 cm^2/hour, based on the child to adult SAR (CalEPA 1996)
- Residential adult – 14,500 cm^2/hour (USEPA 2001k)
- Residential child – 5,200 cm^2/hour, (USEPA 2001k)
- Native American adult – 1,500 cm^2/hour (the high end blueberry value) from USEPA 2000b (referenced by USEPA 2002c)
- Native American child – 300 cm^2/hour, based on the child to adult SAR (CalEPA 1996)

The fraction a.i. retained on foliage (F) is assumed to be 20%. This is the fraction assumed to be present on foliage on the day of application (USEPA 1997d). As stated by the USEPA (1997d), this value is based on the professional judgement and experience of USEPA staff, and is assumed to represent an upper-percentile value.

For certain herbicide a.i., the dose is calculated by including a DAF in the numerator of the equation to account for dermal absorption when the endpoint is selected from an oral study. As shown in Tables 3-1 and 4-16, the calculation of dermal doses for diquat, fluridone, and imazapic include DAFs of 4.1, 40, and 50%, since the dermal NOAELs are based on oral studies. For the other herbicide a.i., the USEPA has either determined that dermal absorption is insignificant, or the dermal NOAELs are based on dermal studies and a DAF factor is not required.

5.2.2.3 Dermal Contact with Water While Swimming

The equation used to estimate a receptor's potential exposure via dermal contact with surface water is as follows:

$$\text{Dose}\ (\text{mg/kg-day}) = \text{EF}_{dw}\ (\text{cm}^2\text{-hr/kg-day}) * \text{Kp}\ (\text{cm/hr}) * \text{C}_w\ (\text{mg a.i./L}) * \text{CF}_3\ (\text{L/cm}^3)$$

where:

$$\text{EF}_{dw}\ (\text{cm}^2\text{-hr/kg-day}) = \frac{\text{SA}\ (\text{cm}^2) * \text{ET(hr/day)}}{\text{BW(kg)}}$$

and where:

Parameter	Units	Definition
EF_{dw}	cm^2-hr/kg-day	Exposure factor for dermal water pathway (see Table 4-5)
Kp	cm/hr	Permeability constant for skin (see Table 4-17)
C_w	mg a.i./L	Concentration in water (for routine use, spray drift, and runoff scenarios, see Table 4-12; for direct spray scenario, see Table 4-13, for accidental spill scenario, see Table 4-14)
CF_3	L/1,000 cm^3	Conversion factor used to convert liters to cm^3
SA	cm^2	Surface area of skin exposed (see Table 4-5)
BW	kg	Body weight (see Table 4-5)

MOEs are calculated as follows:

Dose	NOAEL Type (a)	MOE Equation
Routine	Oral – short/intermediate-term (o)	$\frac{NOAEL_o\ (mg/kg-day)}{Dose_{routine}\ (mg/kg-day)}$
Accident	Oral – short/intermediate-term (o)	$\frac{NOAEL_o\ (mg/kg-day)}{Dose_{accident}\ (mg/kg-day)}$

Concentrations in water resulting from spray drift and surface runoff are presented in Table 4-12 for short-, intermediate-, and long-term exposure. As discussed previously, the intermediate- and long-term exposure scenarios are evaluated in the Uncertainty Analysis (see Section 5.5). The short-term water concentration is used with the short/intermediate-term NOAEL to derive an MOE for short-term exposure. Water concentrations for the accidental scenarios are presented in Tables 4-13 (direct spray) and 4-14 (accidental spill). These water concentrations are used with the short/intermediate-term NOAELs to derive MOEs for the accidental scenarios.

The Kps used in this HHRA are described in Section 4.5.2 and presented in Table 4-17.

The accidental spill scenario assumes that 140 gallons of herbicide mix from a helicopter or 200 gallons of herbicide mix from a batch truck are spilled. These amounts are approximately the largest amounts used by the BLM that can be carried in helicopters or trucks, respectively. The pond is assumed to be ¼ acre in size and 1 meter in depth.

Oral NOAELs are used to evaluate the dermal contact with water pathway because the dermal dose in the equation assumes that the herbicide a.i. is absorbed into the body. Dermal NOAELs assume that the dose is applied to the skin and that the skin acts as a barrier. Therefore, use of dermal NOAELs with an absorbed dose may result in an underestimation of the amount of herbicide a.i. absorbed. Although oral NOAELs have not necessarily been adjusted to reflect an absorbed dose, absorption of these herbicide a.i. is assumed to be much higher via the oral exposure route than the dermal exposure route. Therefore, it is more appropriate to use oral NOAELs for the dermal contact with water pathway. Table 3-1 lists the short/intermediate-term oral NOAELs for each of the herbicide a.i.

5.2.2.4 Ingestion of Drinking Water or Swimming Water

The equation used to estimate a receptor's potential exposure via ingestion of drinking water or swimming water is as follows:

$$Dose\ (mg/kg-day) = EF_{iw}\ (L/kg-day) * C_w\ (mg/L)$$

where:

$$EF_{iw}\ (L/kg-day) = \frac{IR_w\ (L/day)}{BW\ (kg)}$$

and where:

Parameter	Units	Definition
EF_{iw}	L/kg-day	Exposure factor for ingestion of water pathway (seeTable 4-5)
C_w	mg/L	Concentration in water (for routine use, spray drift, and runoff scenarios, see Table 4-12; for direct spray scenario, see Table 4-13, for accidental spill scenario, see Table 4-14)
IR_w	L/day	Ingestion rate for water (see Table 4-5)
BW	kg	Body weight (see Table 4-5)

For incidental ingestion pathways (swimmer), the risk assessment uses the oral NOAELs to calculate MOEs. Oral NOAELs are used rather than PADs because this ingestion is considered incidental rather than dietary. MOEs are calculated as follows:

Dose	NOAEL Type	MOE Equation (Incidental Ingestion)
Routine	Oral – short/intermediate-term (o)	$\frac{NOAEL_o\ (mg/kg-day)}{Dose_{routine}\ (mg/kg-day)}$
Accident	Oral – short/intermediate-term (o)	$\frac{NOAEL_o\ (mg/kg-day)}{Dose_{accident}\ (mg/kg-day)}$

Table 3-1 lists the short/intermediate-term oral NOAELs for each of the herbicide a.i.

For drinking water pathways (hiker/hunter, berry picker, angler, and Native American), it is more relevant to compare the dose with a PAD and calculate a %PAD. The drinking water pathway represents dietary exposure. The PADs are calculated as follows:

Dose	PAD Type	%PAD Equation (Drinking water)
Routine	acute PAD	$\frac{Dose_{routine}\ (mg/kg-day)}{PAD_{chronic}\ (mg/kg-day)} * 100\%$
Accident	acute PAD	$\frac{Dose_{accident}\ (mg/kg-day)}{PAD_{acute}\ (mg/kg-day)} * 100\%$

Table 3-1 lists acute and chronic PADs for the six herbicide a.i. The acute PAD was used for the accidental and short-term routine exposure scenarios. The USEPA has developed an acute PAD only for diflufenzopyr and diquat. Chronic PADs are available for all six herbicide a.i.

Concentrations in water due to spray drift and runoff are presented in Table 4-12 for short-, intermediate-, and long-term exposure. As discussed previously, the intermediate- and long-term exposure scenarios are evaluated in the Uncertainty Analysis (see Section 5.5). The short-term water concentration is used with the short- and intermediate-term NOAELs to derive an MOE for short-term swimming exposure and with the acute PAD to derive a %PAD for the short-term drinking water pathway. Water concentrations for the accidental scenarios are presented in Tables 4-13 (direct spray) and 4-14 (accidental spill). These water concentrations are used with the short/intermediate-term NOAELs to derive MOEs for the accidental swimming scenarios and with the acute PADs to derive %PADs for the accidental drinking water scenarios.

5.2.2.5 Ingestion of Fish

A recreational angler may ingest fish that have bioaccumulated herbicide a.i. present in surface water. The equation used to estimate a receptor's potential exposure via fish ingestion is as follows:

$$Dose\,(mg/kg-day) = EF_{fi}\ (mg/kg-day) * C_W\ (mg/L) * BCF\,(L/kg) * CF_4\ (kg/mg)$$

where:

$$EF_{fi}\ (mg/kg-day) = \frac{IR_f\ (mg/day)}{BW(kg)}$$

And where:

Parameter	Units	Definition
EF_{fi}	mg/kg-day	Exposure factor for fish ingestion pathway (see Table 4-5)
C_w	mg/L	Concentration in water (for routine use, spray drift, and runoff scenarios, see Table 4-12; for direct spray scenario, see Table 4-13, for accidental spill scenario, see Table 4-14)
BCF	L/kg	Bioconcentration factor (see Table 4-18)
CF_4	10^{-6} kg/mg	Conversion factor used to convert mg to kg
IR_f	mg/day	Ingestion rate for fish (see Table 4-5)
BW	kg	Body weight (see Table 4-5)

PADs are calculated as follows:

Dose	PAD Type	%PAD Equation
Routine	Acute PAD	$\frac{\text{Dose}_{\text{routine}}\ (\text{mg/kg-day})}{\text{PAD}_{\text{chronic}}\ (\text{mg/kg-day})} * 100\%$
Accident	Acute PAD	$\frac{\text{Dose}_{\text{accident}}\ (\text{mg/kg-day})}{\text{PAD}_{\text{acute}}\ (\text{mg/kg-day})} * 100\%$

The BCF is defined as the ratio of chemical concentration in the organism to that in the surrounding water. Bioconcentration occurs through uptake and retention of a substance from water only, through gill membranes or other external body surfaces. The BCFs for each of the herbicide a.i. have been estimated using information from the literature and are discussed in Section 4.5.3. The BCFs are presented in Table 4-18.

Table 3-1 lists acute and chronic PADs for the six herbicide a.i. The acute PAD was used for the accidental and short-term routine exposure scenarios. The USEPA has only developed acute PADs for diflufenzopyr and diquat. Chronic PADs are available for all six herbicide a.i.

Concentrations in water are presented in Table 4-12 for short-, intermediate-, and long-term exposure due to spray drift and runoff. As discussed previously, the intermediate- and long-term exposure scenarios are evaluated in the Uncertainty Analysis (see Section 5.5). The short-term water concentration is used with the acute PAD to derive a %PAD for short-term exposure. Water concentrations for the accidental scenarios are presented in Tables 4-13 (direct spray) and 4-14 (accidental spill). These water concentrations are used with the acute PADs to derive %PADs for the accidental scenarios.

5.2.2.6 Ingestion of Berries

It is assumed that several receptors (berry picker, nearby resident, and Native American) could be exposed to herbicide a.i. through berry ingestion. None of the USEPA pesticide documents specifically list an equation for evaluating berry or other food ingestion. However, USEPA (2002c) provides an equation for a pathway involving toddler ingestion of pesticide-treated grass. This equation was used to evaluate ingestion of berries:

$$\text{Dose}\,(\text{mg/kg-day}) = \text{BR}\,(\text{mg/cm}^2) * \text{EF}_{\text{bi}}\,(\text{cm}^2/\text{kg-day})$$

where:

$$\text{EF}_{\text{bi}}\,(\text{cm}^2/\text{kg-day}) = \frac{\text{IR}_{\text{b}}\,(\text{cm}^2/\text{day})}{\text{BW}\,(\text{kg})}$$

$$BR_{routine}\ (mg/cm^2) = DR\ (mg/cm^2) * F$$

$$BR_{accident}\ (mg/cm^2) = AR\ (lb\ a.i./acre) * F * CF_1\ (mg/lb) * CF_2\ (acre/cm^2)$$

and where:

Parameter	Units	Definition
EF_{bi}	cm^2/kg-day	Exposure factor for berry ingestion pathway (see Table 4-5)
BR	mg/cm^2	Berry residue (calculated)
IR_b	cm^2/day	Ingestion rate for berries (see Table 4-5)
BW	kg	Body weight (see Table 4-5)
DR	mg/cm^2	Herbicide active ingredient deposition rate due to spray drift (see Table 4-8)
F	unitless	Fraction a.i. available on berry (discussed below)
AR	lb a.i./acre	Herbicide active ingredient application rate, direct spray accidental scenarios (see Table 4-5)
CF_1	$4.54x10^5$ mg/lb	Conversion factor to convert pounds to mg
CF_2	$2.47x10^{-8}$ acre/cm^2	Conversion factor to convert acres to cm^2

PADs are calculated as follows:

Dose	PAD Type	%PAD Equation
Routine	acute PAD	$\frac{Dose_{routine}\ (mg/kg-day)}{PAD_{chronic}\ (mg/kg-day)} * 100\%$
Accident	acute PAD	$\frac{Dose_{accident}\ (mg/kg-day)}{PAD_{acute}\ (mg/kg-day)} * 100\%$

The equation presented in USEPA (2002c) for toddler grass ingestion uses an IR of 25 cm^2/day assuming that a child eats a handful of grass (2 inch x 2 inch). Therefore, it was necessary to convert the berry IR in units of mg/day (shown in Table 4-5) to a berry IR in units of cm^2/day. The conversion required SA (cm^2) to weight (mg) of berry ratio. Cheung and Yen (1996) calculated a SA to weight ratio of 2 cm^2/g for Thompson Seedless grapes. This value was used to estimate the berry IR in units of cm^2/day. It was assumed that herbicide a.i. deposit only on the top half of a berry. Therefore, half of the SA was used in the equation. The following equation was used to convert the berry IR from units of mg/day to units of cm^2/day:

$$\text{Ingestion rate}\ (cm^2/day) = [\text{Ingestion rate}\ (mg/day)] * [1\,g/1000\,mg] * [2\,cm^2/g] * 0.5$$

The fraction a.i. retained on the berry (F) is assumed to be 20%, similar to the assumption for foliage. This is the fraction assumed to be present on foliage on the day of application (USEPA 1997d). As stated in USEPA (1997d), this value is based on the professional judgement and experience of USEPA staff, and is assumed to represent an upper-percentile value.

Table 3-1 lists acute and chronic PADs for the six herbicide a.i. As discussed previously, the intermediate- and long-term exposure scenarios are evaluated in the Uncertainty Analysis (see Section 5.5). The acute PAD was used for the accidental and short-term routine exposure scenarios. The USEPA has developed an acute PAD for diflufenzopyr and diquat. Chronic PADs are available for all six herbicide a.i.

5.3 Results of Risk Characterization

Using the equations provided above, %PADs and MOEs were calculated for each of the herbicide a.i. for individual receptors. Some of the herbicide a.i. lacked specific PADs and NOAELs; therefore, it was not possible to conduct risk calculations for all exposure pathways and herbicide a.i. For the accidental scenarios, it was assumed that a receptor is exposed to one accidental exposure pathway; therefore, the accidental risks from different scenarios were not added together. For the routine-use scenarios, it was assumed that a receptor could be exposed to a specific herbicide a.i. through several exposure pathways. Therefore, ARIs were calculated for routine-use scenarios. The risk characterization results for the occupational and public receptors are discussed separately.

5.3.1 Occupational Receptors

For the occupational receptors, separate calculations were conducted for routine-use typical AR scenarios, routine-use maximum AR scenarios, and accidental scenarios. For the routine-use scenarios, exposure through dermal and inhalation exposures were evaluated (if appropriate information was available for the specific herbicide a.i.). In the current USEPA OPP program, short-term is defined as 1 day to 1 month, intermediate-term is defined as 1 to 6 months, and long-term is defined as greater than 6 months (USEPA 2001h). The accidental scenario evaluated exposure through dermal absorption. The risk calculation spreadsheets are shown in Appendix B. The results for each herbicide a.i. are summarized below.

5.3.1.1 Dicamba

Dicamba is proposed for use on rangeland, energy and mineral sites, ROW, and recreation and cultural sites. Dicamba may be applied using the following vehicles and methods: truck (boom/broadcast or spot applications), ATV (boom/broadcast or spot applications), horseback (spot applications), and backpack (spot applications). Therefore, potential occupational receptors include an applicator, a mixer/loader, and a combined applicator/mixer/loader. Table 5-2 shows the summary risk results for occupational exposure to dicamba.

Routine use ARIs were calculated for inhalation and dermal exposures under both typical and maximum AR scenarios. Routine use ARIs are greater than 1 under both the typical and maximum AR scenarios, indicating no exceedance of the USEPA's level of concern. Appendix B provides the risk calculations and MOE values.

Under the accidental scenario, it is assumed that dicamba is spilled directly onto an occupational receptor. Because dicamba is provided by the manufacturer in granular form, it cannot be spilled as a concentrated liquid. Therefore, under the accidental scenario, it is assumed that dicamba is spilled on the skin after it has been mixed at the maximum AR concentration. As indicated in Table 5-2, the ARIs for the accidental scenario (maximum AR) for all occupational receptors are less than 1, indicating a level of concern. Because of the conservative nature of the scenario, ARIs were also calculated assuming a spill to worker skin at the typical AR. As indicated in Table 5-2, these ARIs are also below 1, indicating a level of concern. Appendix B provides the intermediate calculations and the MOE values.

These results show that dicamba risks exceed the USEPA's level of concern for all of the occupational receptors under the accidental scenario evaluated, but not under the routine use scenario.

5.3.1.2 Diflufenzopyr

Diflufenzopyr is proposed for use on rangeland and pasture land, energy and mineral sites, ROW, and recreation and cultural sites. Diflufenzopyr may be applied using the following vehicles and methods: truck (boom/broadcast or spot applications), ATV (boom/broadcast or spot applications), horseback (spot applications) and backpack (spot applications). Therefore, potential occupational receptors include an applicator, a mixer/loader, and a combined applicator/mixer/loader. Table 5-3 shows the summary risk results for occupational exposure to diflufenzopyr.

Routine use ARIs were calculated for inhalation exposures under both typical and maximum AR scenarios. No dermal toxicity values are available for diflufenzopyr, which, based on laboratory data, is not expected to be toxic

through the dermal route. Routine use ARIs are greater than 1 under both the typical and maximum AR scenarios, indicating no exceedance of the USEPA's level of concern. Appendix B provides the risk calculations and MOE values.

Under the accidental scenario, it is assumed that diflufenzopyr is spilled directly onto an occupational receptor. Because diflufenzopyr is provided by the manufacturer in granular form, it cannot be spilled as a concentrated liquid. Therefore, under the accidental scenario, it is assumed that diflufenzopyr is spilled on the skin after it has been mixed at the maximum AR concentration. However, based on laboratory data, diflufenzopyr is not expected to be toxic through the dermal route and therefore does not have a short-term dermal NOAEL. Therefore, while spill concentrations were calculated, an accidental scenario ARI was not calculated. Appendix B provides the intermediate calculations and the MOE values.

These results show that diflufenzopyr risks do not exceed the USEPA's level of concern for any of the occupational receptors under the scenarios evaluated.

5.3.1.3 Diquat

Diquat is proposed for use on aquatic sites. Diquat may be applied using the following vehicles and methods: airplane, helicopter, truck (boom/broadcast or spot applications), ATV (boom/broadcast or spot applications), boat (boom/broadcast or spot applications), horseback (spot applications), and backpack (spot applications). Therefore, potential occupational receptors include pilots, applicators, mixer/loaders, and combined applicator/mixer/loaders. Table 5-4 shows the summary risk results for occupational exposure to diquat.

Routine use ARIs were calculated for dermal and inhalation exposures under both typical and maximum AR scenarios. Inhalation UEs are not applicable to the boat scenario. Therefore, long-term ARIs were not calculated for the boat scenario. Under the typical AR scenario, ARIs are less than 1 for the following scenarios, indicating a level of concern:

- Airplane pilot (short-, intermediate-, and long-term exposure)
- Airplane mixer/loader (short-, intermediate-, and long-term exposure)
- Helicopter pilot (short-, intermediate-, and long-term exposure)
- Helicopter mixer/loader (short-, intermediate-, and long-term exposure)
- Backpack applicator/mixer/loader (short-, intermediate-, and long-term exposure)
- Horseback applicator (short-, intermediate-, and long-term exposure)
- Horseback applicator/mixer/loader (short-, intermediate-, and long-term exposure)

Under the maximum AR scenario, ARIs are less than one for the following scenarios, indicating a level of concern:

- Airplane pilot (short-, intermediate-, and long-term exposure)
- Airplane mixer/loader (short-, intermediate-, and long-term exposure)
- Helicopter pilot (short-, intermediate-, and long-term exposure)
- Helicopter mixer/loader (short-, intermediate-, and long-term exposure)
- Backpack applicator/mixer/loader (short-, intermediate-, and long-term exposure)
- Horseback applicator (short-, intermediate-, and long-term exposure)
- Horseback mixer/loader (short-, intermediate-, and long-term exposure)
- Horseback applicator/mixer/loader (short-, intermediate-, and long-term exposure)
- ATV spot applicator (short-, intermediate-, and long-term exposure)
- ATV spot applicator/mixer/loader (short-, intermediate-, and long-term exposure)
- ATV boom/broadcast applicator (short-, intermediate-, and long-term exposure)
- ATV boom/broadcast mixer/loader (short-, intermediate-, and long-term exposure)
- ATV boom/broadcast applicator/mixer/loader (short-, intermediate-, and long-term exposure)
- Truck mount spot applicator (short-, intermediate-, and long-term exposure)
- Truck mount spot mixer/loader (short-, intermediate-, and long-term exposure)

- Truck mount spot applicator/mixer/loader (short-, intermediate-, and long-term exposure)
- Truck mount boom/broadcast applicator (short-, intermediate-, and long-term exposure)
- Truck mount boom/broadcast mixer/loader (short-, intermediate-, and long-term exposure)
- Truck mount boom/broadcast applicator/mixer/loader (short-, intermediate-, and long-term exposure)

As noted in Table 4-2, all application scenarios for diquat require the use of gloves. Diquat is provided by the manufacturer in liquid form. Therefore, accidental scenario ARIs were calculated assuming the concentrated herbicide a.i. is spilled directly onto an occupational receptor. As indicated in Table 5-3, the ARIs for the accidental scenario (concentrated liquid) for all occupational receptors are less than 1, indicating a level of concern. Because of the conservative nature of the scenario (i.e., a spill of concentrated liquid directly to worker skin), ARIs were also calculated assuming a spill to worker skin after at the maximum and typical ARs. As indicated on Table 5-4, the ARIs assuming a spill of diquat solution under both the typical and maximum ARs are below 1, indicating a level of concern.

These results show that diquat risks exceed the USEPA's level of concern for the occupational receptors under the majority of terrestrial scenarios evaluated, as listed above.

5.3.1.4 Fluridone

Fluridone is proposed for use on aquatic sites. Fluridone may be applied using the following vehicles and methods: airplane, helicopter, truck (boom/broadcast or spot applications), ATV (boom/broadcast or spot applications), boat (boom/broadcast or spot applications), horseback (spot applications), and backpack (spot applications). Therefore, potential occupational receptors include pilots, applicators, mixer/loaders, and combined applicator/mixer/loaders. Table 5-5 shows the summary risk results for occupational exposure to fluridone.

Routine use ARIs were calculated for dermal and inhalation exposures under both typical and maximum AR scenarios. Routine use ARIs are greater than 1 for the typical AR scenarios, indicating no exceedance of the USEPA's level of concern. Under the maximum AR scenario, ARIs are less than one for the following scenarios, indicating a level of concern:

- Airplane mixer/loader (intermediate- and long-term exposure)
- Helicopter mixer/loader (long-term exposure)

Fluridone is provided by the manufacturer in liquid form. Therefore, accidental scenario ARIs were calculated assuming the concentrated herbicide a.i. is spilled directly onto an occupational receptor. The ARIs for the accidental scenario for all occupational receptors are less than 1, indicating a level of concern. Because of the conservative nature of the scenario (i.e., a spill of concentrated liquid directly to worker skin), ARIs were also calculated assuming a spill to worker skin after at the maximum and typical ARs. As indicated on Table 5-5, the ARIs assuming a spill of fluridone solution under both the typical and maximum ARs are below 1, indicating a level of concern.

These results show that fluridone risks could exceed USEPA's level of concern for all occupational receptors under the accidental scenario, and to the airplane mixer/loader under the routine use (maximum AR) scenario for intermediate- and long-term exposures, and to the helicopter mixer/loader under the routine use (maximum AR) scenario for long-term exposures.

5.3.1.5 Imazapic

Imazapic is proposed for use on rangeland, public domain forestland, energy and mineral sites, ROW, and recreation and cultural sites. Imazapic may be applied using the following vehicles and methods: airplane, helicopter, truck (boom/broadcast or spot applications), ATV (boom/broadcast or spot applications), horseback (spot applications), and backpack (spot applications). Therefore, potential occupational receptors include pilots, applicators, mixer/loaders, and combined applicator/mixer/loaders. Table 5-6 shows the summary risk results for occupational exposure to imazapic.

Routine use ARIs were calculated for dermal and inhalation exposures under both typical and maximum AR scenarios. No short- or intermediate-term dermal NOAELs are available for imazapic as dermal toxicity tests were negative even at high doses (see Section 2.2.5.2). Therefore, the short- and intermediate-term ARIs are based on the inhalation pathway, and the long-term ARI is based on both the dermal and inhalation pathways. Routine use ARIs are greater than 1 under both the typical and maximum AR scenarios, indicating no level of concern.

Imazapic is provided by the manufacturer in liquid form. Therefore, under the accidental scenario, it was assumed that the concentrated herbicide a.i. is spilled directly onto an occupational receptor. However, imazapic has not been shown to be toxic via short-term exposures via the dermal route, and no NOAELs have been identified. Therefore, while spill concentrations were calculated, an accidental scenario ARI was not calculated. Appendix B provides the intermediate calculations and the MOE values.

These results show that imazapic risks are not expected to exceed the USEPA's level of concern for any of the occupational receptors under the scenarios evaluated.

5.3.1.6 Sulfometuron Methyl

Sulfometuron methyl is proposed for use on public domain forestland, energy and mineral sites, ROW, and recreation and cultural sites. Sulfometuron methyl may be applied using the following vehicles and methods: helicopter, truck (boom/broadcast or spot applications), ATV (boom/broadcast or spot applications), horseback (spot applications), and backpack (spot applications); however, helicopter applications would not occur on recreation and cultural sites. Therefore, potential occupational receptors include pilots, applicators, mixer/loaders, and combined applicator/mixer/loaders. Table 5-7 shows the summary risk results for occupational exposure to sulfometuron methyl.

Routine use ARIs were calculated for dermal and inhalation exposures under both typical and maximum AR scenarios. Routine use ARIs are greater than 1 under both the typical and maximum AR scenarios, indicating no level of concern.

Under the accidental scenario, it is assumed that sulfometuron methyl is spilled directly onto an occupational receptor. Because sulfometuron methyl is provided by the manufacturer in granular form, it cannot be spilled as a concentrated liquid. Therefore, under the accidental scenario, it is assumed that sulfometuron methyl is spilled on the skin after it has been mixed at the maximum AR concentration. However, sulfometuron has not been shown to be toxic via short-term exposures via the dermal route and no NOAELs have been identified. Therefore, while spill concentrations were calculated, an accidental scenario ARI was not calculated.

These results show that sulfometuron methyl risks are not expected to exceed the USEPA's level of concern for any of the occupational receptors under the scenarios evaluated.

5.3.2 Public Receptors

The following public receptors were evaluated for potential exposure to herbicide a.i. under both routine (typical and maximum AR) and accidental exposure scenarios:

- Angler
- Berry picker - adult
- Berry picker - child
- Hiker/hunter
- Native American- adult
- Native American- child
- Nearby resident - adult
- Nearby resident - child
- Swimmer - adult

- Swimmer - child

Table 4-4 lists the exposure pathways through which each receptor is assumed to be exposed, and Section 4.3 describes the receptors. The assumption under the routine-use scenarios is that public receptors are potentially exposed to media impacted by spray drift, while the assumption under the accidental scenarios is that receptors are potentially exposed to media directly sprayed by herbicide a.i. applications. While it is possible that public receptors use public lands under intermediate- and long-term time frames, it is unlikely that public receptors would be exposed to herbicides under the routine use scenario for more than a short-term exposure, which is defined as 1 day to 1 month (USEPA 2001h). Therefore, short-term exposures are evaluated below. An evaluation of the public receptors under an intermediate- and a long-term exposure scenario is included in the Uncertainty Analysis (see Section 5.5). Therefore, public receptors may be impacted by spray drift under routine use scenarios for the following applications:

- Aerial – plane
- Aerial – helicopter
- Boom/broadcast (truck or ATV), both low and high boom scenarios were evaluated

Because spot applications are small and focused, and very little if any spray drift is generated, public receptors are not assumed to be impacted by herbicide a.i. spray through routine use from the following applications:

- Backpack
- Horseback
- ATV - spot
- Truck - spot

Public receptors may be impacted by direct spray under the accidental scenarios for all the application methods. However, the evaluation of the spot scenarios may result in an overestimate of exposure as the spot application method is very focused, and may not encompass an area of vegetation large enough to support some of the exposure scenarios (e.g., a spot application may not encompass enough berries to support the assumed IR or may not encompass enough foliage to support the assumed dermal contact).

Appendix B presents the risk calculation spreadsheets. The results are summarized below.

5.3.2.1 Dicamba

Dicamba is proposed for use on rangeland, energy and mineral sites, ROW, and recreation and cultural sites. Dicamba may be applied using the following vehicles and methods: truck (boom/broadcast or spot applications), ATV (boom/broadcast or spot applications), horseback (spot applications), and backpack (spot applications). All public receptors are assumed to be potentially exposed to dicamba spray drift resulting from boom/broadcast (both low-boom and high-boom) application methods from trucks or ATVs. As noted above, spot applications are small and focused, and very little if any spray drift is generated; therefore, public receptors are not assumed to be impacted by herbicide a.i. spray from spot applications.

Under the routine use scenario, it is assumed that public receptors are exposed to spray drift via dermal contact, incidental ingestion, and dietary exposure pathways under both typical and maximum AR scenarios (ARs are shown in Table 4-1). The ARIs combine all the exposure estimates to derive a cumulative effect ARI. The routine use scenario ARIs are presented in Table 5-8. Routine use scenario ARIs are greater than 1 under both the typical and maximum AR scenarios for all public receptors, indicating no level of concern.

Under the accidental scenario, it is assumed that public receptors are exposed directly to maximum herbicide a.i. ARs (as shown in Table 4-1) via dermal contact (direct spray of receptor, contact with directly sprayed vegetation, and contact with directly sprayed water), incidental ingestion of water while swimming, or dietary exposure pathways (drinking water, berry ingestion, and fish ingestion). The same maximum AR applies to all dicamba treatment application methods, as shown in Table 4-1. The accidental scenario for a pond assumes that receptors swim in or

obtain drinking water from a pond that has been directly sprayed with herbicide a.i. or that has received a spill from a truck. Cumulative accidental ARIs were not calculated, as it is assumed that each receptor would be accidentally exposed via one potential exposure pathway. The accidental scenario ARIs are presented in Table 5-9. All accidental scenario ARIs are greater than 1, indicating no level of concern.

These results indicate that dicamba risks are not expected to exceed the USEPA's level of concern for public receptors under the scenarios evaluated.

5.3.2.2 Diflufenzopyr

Diflufenzopyr is proposed for use on rangeland and pasture land, energy and mineral sites, ROW, and recreation and cultural sites. Diflufenzopyr may be applied using the following vehicles and methods: truck (boom/broadcast or spot applications), ATV (boom/broadcast or spot applications), horseback (spot applications), and backpack (spot applications). All public receptors are assumed to be potentially exposed to diflufenzopyr spray drift resulting from boom/broadcast (both low-boom and high-boom) application methods from trucks or ATVs. As noted above, spot applications are small and focused, and very little if any spray drift is generated; therefore, public receptors are not assumed to be impacted by herbicide a.i. spray from spot applications.

Under the routine use scenario, it is assumed that public receptors are exposed to spray drift via dermal contact, incidental ingestion, and dietary exposure pathways under both typical and maximum AR scenarios (ARs are shown in Table 4-1). The ARIs combine all the exposure estimates to derive a cumulative effect ARI. The routine use scenario ARIs are presented in Table 5-10. Because laboratory studies have demonstrated that diflufenzopyr is not toxic by the dermal exposure route, dermal NOAELs were not identified, and the dermal pathway is not evaluated for diflufenzopyr in this HHRA. Routine use scenario ARIs are greater than 1 under both the typical and maximum AR scenarios for all public receptors, indicating no level of concern.

Under the accidental scenario, it is assumed that public receptors are exposed directly to maximum herbicide a.i. ARs (as shown in Table 4-1) via dermal contact (direct spray of receptor, contact with directly sprayed vegetation, and contact with directly sprayed water), incidental ingestion of water while swimming, or dietary exposure pathways (drinking water, berry ingestion, and fish ingestion). The same maximum AR applies to all diflufenzopyr treatment application methods, as shown in Table 4-1. The accidental scenario for a pond assumes that receptors swim in or obtain drinking water from a pond that has been directly sprayed with herbicide a.i. or that has received a spill from a truck. Cumulative accidental ARIs were not calculated, as it is assumed that each receptor would be accidentally exposed via one potential exposure pathway. The accidental scenario ARIs are presented in Table 5-11. The ARIs for dermal contact pathways were not calculated because diflufenzopyr has not been shown to be toxic via the dermal exposure pathway (see Section 3.2.1.2). All accidental scenario ARIs are greater than 1, indicating no level of concern.

These results indicate that diflufenzopyr risks are not expected to exceed the USEPA's level of concern for public receptors under the scenarios evaluated.

5.3.2.3 Diquat

Diquat is proposed for use on aquatic sites. Diquat may be applied using the following vehicles and methods: airplane, helicopter, truck (boom/broadcast or spot applications), ATV (boom/broadcast or spot applications), boat (boom/broadcast or spot applications), horseback (spot applications), and backpack (spot applications). All public receptors are assumed to be potentially exposed to diquat spray drift resulting from aerial applications from airplanes or helicopters and boom/broadcast (both low-boom and high-boom) application methods from trucks, ATVs, or boats. As noted above, spot applications are small and focused, and very little if any spray drift is generated; therefore, public receptors are not assumed to be impacted by herbicide a.i. spray from spot applications.

Under the routine use scenario, it is assumed that public receptors are exposed to spray drift via dermal contact, incidental ingestion, and dietary exposure pathways under both typical and maximum AR scenarios (ARs shown in Table 4-1). The ARIs combine all the exposure estimates to derive a cumulative effect ARI. The routine use scenario

ARIs are presented in Table 5-12. Table 5-12 summarizes these results by application method. The ARIs are below 1 for the following scenarios under the typical AR scenario, indicating a level of concern:

- Residential (child) – airplane and helicopter applications

ARIs for diquat are below 1 for the following scenarios under the maximum AR scenario, indicating a level of concern:

- Hiker/hunter (adult) – airplane and helicopter applications
- Berry picker (child) – airplane and helicopter applications, high-boom applications
- Berry picker (adult) – airplane and helicopter applications
- Angler (adult) – airplane and helicopter applications
- Residential (child) – airplane and helicopter applications, low-boom applications, high-boom applications
- Residential (adult) – airplane and helicopter applications, low-boom applications, high-boom applications
- Native American (child) – airplane and helicopter applications, high-boom applications
- Native American (adult) – airplane and helicopter applications

Under the accidental scenario, it is assumed that public receptors are exposed directly to maximum herbicide a.i. ARs (as shown in Table 4-1) via dermal contact (direct spray of receptor, contact with directly sprayed vegetation, and contact with directly sprayed water), incidental ingestion of water while swimming, or dietary exposure pathways (drinking water, berry ingestion, and fish ingestion). The same maximum AR applies to all diquat treatment application methods, as shown in Table 4-1. The accidental scenario for a pond assumes that receptors swim in or obtain drinking water from a pond that has been directly sprayed with herbicide a.i. or that has received a spill (from a truck or helicopter). Cumulative accidental ARIs were not calculated, as it is assumed that each receptor would be accidentally exposed via one potential exposure pathway. The accidental scenario ARIs are presented in Table 5-13. The ARIs for diquat are less than 1 for the following receptors and pathways, indicating a level of concern.

- Angler (adult) – direct spray, contact with directly sprayed foliage, and drinking water from a pond receiving a helicopter spill
- Berry picker (adult) – direct spray, contact with directly sprayed foliage, and drinking water from a pond receiving a helicopter spill
- Berry picker (child) – direct spray, contact with directly sprayed foliage, and drinking water from a pond receiving a truck or helicopter spill
- Hiker/hunter (adult) – direct spray, contact with directly sprayed foliage, and drinking water from a pond receiving a helicopter spill
- Native American (adult) – direct spray and contact with directly sprayed foliage
- Native American (child) – direct spray and contact with directly sprayed foliage, and drinking water from a pond receiving a helicopter spill
- Nearby resident (adult) – direct spray and contact with directly sprayed foliage
- Nearby resident (child) – direct spray and contact with directly sprayed foliage
- Swimmer (adult) – swimming in a pond receiving a truck or helicopter spill
- Swimmer (child) – swimming in a pond receiving a truck or helicopter spill

A second set of calculations was performed for the scenarios listed above with ARIs below 1 under the maximum AR assuming that herbicide a.i. is sprayed or spilled at the typical rather than the maximum AR (see Table 4-1). Table 5-14 presents the ARIs under the typical AR scenario for accidental exposures. ARIs for diquat for the following receptors and scenarios are below 1, indicating a level of concern:

- Angler (adult) – direct spray
- Berry picker (adult) – direct spray
- Berry picker (child) – direct spray and drinking water from a pond receiving a helicopter spill
- Hiker/hunter (adult) – direct spray

- Native American (adult) – direct spray
- Native American (child) – direct spray
- Nearby resident (adult) – direct spray and contact with directly sprayed foliage
- Nearby resident (child) – direct spray and contact with directly sprayed foliage
- Swimmer (child) – swimming in a pond receiving a truck or helicopter spill

These results show that diquat risks could exceed the USEPA's level of concern for public receptors under certain scenarios. No risks were indicated for low-boom or high-boom application methods under typical ARs for short-, intermediate-, or long-term exposure scenarios for diquat.

5.3.2.4 Fluridone

Fluridone is proposed for use on aquatic sites. Fluridone may be applied using the following vehicles and methods: airplane, helicopter, truck (boom/broadcast or spot applications), ATV (boom/broadcast or spot applications), boat (boom/broadcast or spot applications), horseback (spot applications), and backpack (spot applications). All public receptors are assumed to be potentially exposed to fluridone spray drift resulting from aerial applications from airplanes or helicopters and boom/broadcast (both low-boom and high-boom) application methods from trucks, ATVs, or boats. As noted above, spot applications are small and focused, and very little if any spray drift is generated; public receptors are not assumed to be impacted by herbicide a.i. spray from spot applications.

Under the routine use scenario, it is assumed that public receptors are exposed to spray drift via dermal contact, incidental ingestion, and dietary exposure pathways under both typical and maximum AR scenarios (shown in Table 4-1). The ARIs combine all the exposure estimates to derive a cumulative effect ARI. The routine use scenario ARIs are presented in Table 5-15. Toxicity values are not available for acute dietary exposure for fluridone. Therefore, short-term ARIs are based on dermal and incidental oral exposure.

Routine use scenario ARIs are greater than 1 under the typical and maximum AR scenarios for all public receptors, indicating no exceedance of the USEPA's level of concern.

Under the accidental scenario, it is assumed that public receptors are exposed directly to maximum herbicide a.i. ARs (shown in Table 4-1) via dermal contact (direct spray of receptor, contact with directly sprayed vegetation, and contact with directly sprayed water), incidental ingestion of water while swimming, or dietary exposure pathways (drinking water, berry ingestion, and fish ingestion). The accidental scenario for a pond assumes that receptors swim in or obtain drinking water from a pond that has been directly sprayed with herbicide a.i. or that has received a spill (from a truck or helicopter). Cumulative accidental ARIs were not calculated, as it is assumed that each receptor would be accidentally exposed via one potential exposure pathway. The accidental scenario ARIs for fluridone are presented in Table 5-16. Accidental scenario ARIs were calculated for dermal exposure and incidental oral pathways only, because acute dietary toxicity values are not available. ARIs for fluridone are less than 1 for the following receptors and pathways, indicating a level of concern:

- Berry picker (child) – direct spray
- Native American (child) – direct spray
- Residential (child) – direct spray and contact with directly sprayed foliage

A second set of calculations was performed for the scenarios listed above with ARIs below 1 under the maximum AR assuming that herbicide a.i. is sprayed or spilled at the typical rather than the maximum AR (see Table 4-1). Table 5-17 indicates the ARIs under the typical AR scenario for accidental exposures. The ARIs are equal to or above 1, indicating no exceedance of USEPA's level of concern.

These results show that fluridone risks do not exceed the USEPA's level of concern under the routine-use typical AR scenario, but could exceed the USEPA's level of concern for the nearby resident (adult and child) under the routine-use maximum AR scenario and the nearby resident (adult and child), the berry picker (child) and the Native American (child) under the accidental scenarios.

5.3.2.5 Imazapic

Imazapic is proposed for use on rangeland, public domain forestland, energy and mineral sites, ROW, and recreational and cultural sites. Imazapic may be applied using the following vehicles and methods: airplane, helicopter, truck (boom/broadcast or spot applications), ATV (boom/broadcast or spot applications), horseback (spot applications), and backpack (spot applications). All public receptors are assumed to be potentially exposed to imazapic spray drift resulting from aerial applications from airplanes or helicopters and boom/broadcast (both low-boom and high-boom) application methods from trucks or ATVs. As noted above, spot applications are small and focused, and very little if any spray drift is generated; therefore, public receptors are not assumed to be impacted by herbicide a.i. spray from spot applications.

Under the routine use scenario, it is assumed that public receptors are exposed to spray drift via dermal contact, incidental ingestion, and dietary exposure pathways under both typical and maximum AR scenarios (ARs are shown in Table 4-1). The ARIs combine all the exposure estimates to derive a cumulative effect ARI. The routine use scenario ARIs for imazapic are presented in Table 5-18. Toxicity values are not available for acute dietary exposure, short-term dermal exposure, and intermediate-term dermal exposure. Therefore, short-term ARIs are based on incidental oral exposure (and therefore are calculated only for swimming pathways). Routine use scenario ARIs for imazapic are greater than 1 under both the typical and maximum AR scenarios for all public receptors, indicating no exceedance of the USEPA's level of concern under the scenarios evaluated.

Under the accidental scenario, it is assumed that public receptors are exposed directly to maximum herbicide a.i. ARs (as shown on Table 4-1) via dermal contact (direct spray of receptor, contact with directly sprayed vegetation, and contact with directly sprayed water), incidental ingestion of water while swimming, or dietary exposure pathways (drinking water, berry ingestion, and fish ingestion). The accidental scenario for a pond assumes that receptors swim in or obtain drinking water from a pond that has been directly sprayed with herbicide a.i. or that has received a spill (from a truck or helicopter). Cumulative accidental ARIs were not calculated, as it is assumed that each receptor would be accidentally exposed via only one potential exposure pathway. The accidental scenario ARIs are presented in Table 5-19. Accidental scenario ARIs for imazapic were calculated for incidental oral pathways only, because acute dietary and short-term dermal toxicity values are not available. Therefore, ARIs were calculated only for the swimming pathways. The ARIs for the swimming pathways are greater than 1, indicating exceedance of the USEPA's level of concern under the scenarios evaluated.

These results show that imazapic risks are not expected to exceed the USEPA's level of concern for any of the public receptors under the scenarios evaluated.

5.3.2.6 Sulfometuron Methyl

Sulfometuron methyl is proposed for use on public domain forestland, energy and mineral sites, ROW, and recreational and cultural sites. Sulfometuron methyl may be applied using the following vehicles and methods: helicopter, truck (boom/broadcast or spot applications), ATV (boom/broadcast or spot applications), horseback (spot applications), and backpack (spot applications). All public receptors are assumed to be potentially exposed to sulfometuron methyl spray drift resulting from aerial applications from helicopters and boom/broadcast (both low-boom and high-boom) application methods from trucks or ATVs. As noted above, spot applications are small and focused, and very little if any spray drift is generated; therefore, public receptors are not assumed to be impacted by herbicide a.i. spray from spot applications.

Under the routine use scenario, it is assumed that public receptors are exposed to spray drift via dermal contact, incidental ingestion, and dietary exposure pathways under both typical and maximum AR scenarios (ARs are shown in Table 4-1). The ARIs combine all the exposure estimates to derive a cumulative effect ARI. The routine use scenario ARIs for sulfometuron methyl are presented in Table 5-20. Toxicity values are not available for acute dietary exposure or dermal exposure. Therefore, short-term ARIs are based on incidental oral exposure (and therefore are calculated only for swimming pathways). Routine use scenario ARIs for sulfometuron methyl are greater than 1 under both the typical and maximum AR scenarios for all public receptors, indicating no exceedance of the USEPA's level of concern under the scenarios evaluated.

Under the accidental scenario, it is assumed that public receptors are exposed directly to maximum herbicide a.i. ARs via dermal contact (direct spray of receptor, contact with directly sprayed vegetation, and contact with directly sprayed water), incidental ingestion of water while swimming, or dietary exposure pathways (drinking water, berry ingestion, and fish ingestion). The accidental scenario for a pond assumes that receptors swim in or obtain drinking water from a pond that has been directly sprayed with an herbicide a.i. or that has received a spill (from a truck or helicopter). Cumulative accidental ARIs were not calculated, as it is assumed that each receptor would be accidentally exposed via only one potential exposure pathway. The accidental scenario ARIs for sulfometuron methyl are presented in Table 5-21. Accidental scenario ARIs were calculated for incidental oral pathways only because acute dietary and short-term dermal toxicity values are not available. Therefore, ARIs were calculated only for the swimming pathways. The ARIs for the swimming pathways are greater than 1, indicating no exceedance of the USEPA's level of concern under the scenarios evaluated.

These results show that sulfometuron methyl risks are not expected to exceed the USEPA's level of concern for any of the public receptors under the scenarios evaluated.

5.4 Evaluation of Currently Available Herbicide Active Ingredients

This section evaluates the toxicity values used for herbicide a.i. that were not evaluated in the HHRA, but are currently available to the BLM. These herbicide a.i. were evaluated in earlier EISs—the *Final Environmental Impact Statement Vegetation Treatment on BLM Lands in Thirteen Western States* (1991 13-State EIS; USDI BLM 1991) and the *Final Environmental Impact Statement California Vegetation Management* (1988 California EIS; USDI BLM 1988). This section also compares the receptors and exposure pathways used in the earlier risk assessments with those used in this HHRA. The purpose of this comparison is to determine whether the earlier BLM risk assessments were appropriate for current use.

5.4.1 Evaluation of Dose-response Values Used in Previous EISs

This section compares the dose-response values used for herbicide a.i. that are in current use and were evaluated in previous EISs with values developed under current USEPA OPP policy. Most of the herbicide a.i. were evaluated in the *Final Environmental Impact Statement Vegetation Treatment on BLM Lands in Thirteen Western States* risk assessment. Three of the herbicides (asulam, 2,4-DP, and fosamine) were evaluated in the *Final Environmental Impact Statement California Vegetation Management*. Section 3.0 includes a discussion of the various dose-response values that are used in this HHRA. Table 5-22 compares the NOAELs used in the previous EISs with current NOAELs and PADs. The earlier HHRAs used two NOAELs for each herbicide a.i.—a systemic NOAEL and a reproductive/teratogenic NOAEL. In contrast, the current approach from the USEPA OPP uses a variety of NOAELs based on exposure duration rather than specific health outcome, as well as acute and chronic dietary PADs as shown in Table 5-22. The PAD is the NOAEL divided by an UF, typically 100. Therefore, multiplying the PAD by 100 allows one to compare the value to a NOAEL. The NOAELs used in the current risk assessment are based on the most sensitive effect (i.e., they were not identified separately by endpoints, such as systemic effects or reproductive/teratogenic effects); therefore, they are conservative values. Lower NOAELs indicate higher potential toxicity. The CSFs used in the earlier HHRAs were also compared with any recent CSFs for those a.i. Higher CSFs indicate higher potential toxicity.

Dicamba was evaluated in the 1991 13-State EIS HHRA, and is also evaluated in the current HHRA because it is a component with diflufenzopyr in herbicides. Therefore, dicamba is not included in the comparison table (Table 5-22). Sulfometuron methyl was also evaluated in both the 1991 13- State EIS HHRA and the current HHRA because of its potential impact on off-site vegetation. Therefore, sulfometuron methyl is also not included in the comparison (Table 5-22).

Table 5-22 shows that the dose-response values used in the earlier HHRAs for most of the herbicide a.i. are conservative in comparison to current toxicity values, with the following exceptions:

5.4.1.1 Asulam

The short-term and intermediate-term NOAEL for all exposure routes is 50 mg/kg-day, which is the same value as the systemic and reproductive NOAELs used in the 1988 California EIS HHRA. The long-term NOAEL for all exposure routes is 36 mg/kg-day, which is slightly lower than the NOAEL of 50 mg/kg-day used in the 1988 California EIS HHRA. The HHRA showed that routine exposures to the public and workers do not result in unacceptable risks. The slightly lower long-term NOAEL would not significantly change this outcome. The BLM has not used asulam since at least 1997.

5.4.1.2 Diuron

The chronic dietary PAD of 0.003 mg/kg-day is based on a LOAEL of 1 mg/kg-day. Assuming that there is an extra UF of 3 because of the use of a LOAEL rather than a NOAEL, the corresponding NOAEL would be 0.3 mg/kg-day. This value is slightly lower than the systemic NOAEL of 0.625 mg/kg-day used in the 1991 13-State EIS HHRA, indicating that the estimated noncancer risk for diuron could be higher using the new toxicity value. In addition, the USEPA has developed a CSF for diuron of 1.91×10^{-2}/mg/kg-day, whereas the 1991 13-State EIS HHRA did not evaluate diuron for its potentially carcinogenic effects. The 4-year average (2000 to 2003) of AT by the BLM using diuron is 964; therefore, this a.i. has been used recently though not extensively. The 1991 13-State EIS HHRA showed potential unacceptable risks for this herbicide a.i., and this conclusion would remain if the more recent toxicity values were used.

5.4.1.3 Fosamine

The chronic dietary PAD of 0.01 mg/kg-day is based on a NOAEL of 10 mg/kg-day. This value is lower than the systemic NOAEL of 25 mg/kg-day used in the 1988 California EIS HHRA, indicating that the estimated noncancer risk for fosamine could be higher using the new toxicity value. The 1988 California EIS HHRA showed that routine exposures to the public and workers do not result in unacceptable risks for this herbicide a.i. Because the difference between the two NOAELs is relatively small, this outcome would likely not change with use of the newer toxicity value. The BLM has treated less than 50 acres annually using fosamine since 1997.

5.4.1.4 Simazine

The chronic dietary PAD of 0.005 mg/kg-day is based on a NOAEL of 0.5 mg/kg-day, which is lower than the NOAEL of 5 mg/kg-day used in the 1991 13-State EIS HHRA, indicating that the estimated noncancer risk for simazine could be higher using the new toxicity value. However, simazine has not been used since 1997; therefore, there is no exposure to this herbicide a.i., and the toxicity value change would not significantly affect its use.

5.4.1.5 Triclopyr

The chronic dietary PAD of 0.005 mg/kg-day is based on a NOAEL of 0.5 mg/kg-day, which is lower than the NOAEL of 2.5 mg/kg-day used in the 1991 13-State EIS HHRA, indicating that the estimated noncancer risk for triclopyr could be 5-fold higher using the new toxicity value. The BLM treated approximately 4,737 annually using triclopyr during 2000 to 2003; therefore, this a.i. has been used recently. The 1991 13-State EIS HHRA showed potential unacceptable risks for this herbicide a.i., and this conclusion would remain if the more recent toxicity values were used.

In summary, diuron, simazine, and triclopyr are the only herbicide a.i. for which there are more stringent current dose-response values than those used in earlier HHRAs. Simazine has not been used in the 4-year period of 50 mg/kg-day therefore, there is no exposure to this herbicide a.i., and the toxicity value change does not affect potential risks. Both

diuron and triclopyr were found to pose potentially unacceptable risks in the BLM 1991 risk assessment; therefore, this conclusion would remain if the more stringent current toxicity values were used.

5.4.2 Evaluation of Receptors and Exposure Pathways Used in the Earlier Human Health Risk Assessments

The *Final Environmental Impact Statement Vegetation Treatment on BLM Lands in Thirteen Western States*, the *Final Environmental Impact Statement California Vegetation Management*, and this HHRA evaluated occupational and public receptors. The risk assessments evaluated the same occupational scenarios—that of a worker potentially exposed to herbicide a.i. via dermal contact and inhalation during routine applications and of a worker potentially exposed to an accidental spill of herbicide a.i. to his or her skin.

Table 5-23 compares the public receptors and exposure pathways evaluated in the risk assessments. The receptors in both risk assessments are similar. The exposure scenarios are also similar, with two exceptions. The 1991 13-State EIS HHRA did not evaluate a swimming scenario, and this HHRA does not evaluate a Native American game ingestion scenario (in accordance with discussions with the USEPA). Therefore, the current risk assessment evaluates a more conservative pond pathway and a slightly less conservative Native American pathway. Other than these minor differences, the exposure pathways for both risk assessments are similar.

5.4.3 Conclusions of Present Herbicide Active Ingredient Evaluation

Based on the general similarity of the risk assessments conducted by the BLM in 1988 and 1991 and the current risk assessment, it is likely that the risk estimates calculated previously would not differ significantly from risk estimates calculated for the present herbicide a.i. using the updated risk assessment methods and the updated toxicity values. Therefore, new risk assessments were not conducted for the herbicides currently in use other than sulfometuron methyl and dicamba. These herbicide a.i. were evaluated in the current HHRA because of alternative exposure pathways and concomitant exposures with other herbicide a.i.

5.5 Uncertainty Analysis

Uncertainty is introduced into the risk assessment in several places throughout the process. Every time an assumption is made, some level of uncertainty is introduced into the risk assessment. In accordance with USEPA guidance (USEPA 1989), the uncertainty associated with each step of the risk characterization process is discussed in this section of the report.

Within any of the four steps of the human health risk evaluation process, assumptions must be made due to a lack of absolute scientific knowledge. Some of the assumptions are supported by considerable scientific evidence, while others have less support. Every assumption introduces some degree of uncertainty into the risk evaluation process. Regulatory risk evaluation methodology requires that conservative assumptions be made throughout the risk evaluation to ensure that public health is protected. Therefore, when all of the assumptions are combined, it is much more likely that risks are overestimated rather than underestimated.

5.5.1 Hazard Identification

The Hazard Identification step involves identifying the herbicide a.i. to be evaluated quantitatively in the HHRA and providing toxicity information. The six herbicide a.i. evaluated in this HHRA were identified by the BLM, and represent the considered herbicide a.i. that have not been evaluated in previous EISs (with the exception of sulfometuron methyl and dicamba, which were previously evaluated). Toxicity information on these herbicide a.i. was collected mainly from USEPA reports that have compiled results of toxicity studies conducted by the manufacturers and other entities. For the most part, the USEPA had sufficient information to place the herbicide a.i. in the appropriate acute toxicity categories, and to determine their carcinogenic potential. Appropriate studies were available on subchronic, chronic, developmental, and reproductive toxicity. While there is always uncertainty in extrapolating

animal information to humans, sufficient information was available to make a determination on toxicity for these herbicide a.i.

5.5.2 Dose-response Assessment

The purpose of the dose-response assessment is to define the relationship between the dose of a chemical and the likelihood or magnitude of an adverse effect (response). Risk assessment methodologies typically divide potential health effects of concern into two general categories: effects with a threshold (noncarcinogenic) and effects assumed to be without a threshold (potentially carcinogenic). None of the six herbicide a.i. evaluated in this HHRA are designated as potential carcinogens by the USEPA; therefore, noncancer dose-response values were used in the evaluation. There are several sources of uncertainty in the development of dose-response values.

5.5.3 Animal-to-human Extrapolation

For many chemicals, animal studies provide the only reliable information on which to base an estimate of adverse human health effects. Extrapolation from animals to humans introduces uncertainty into the risk characterization. Usually, the difference between the human reaction to a chemical and the test animal reaction to a chemical is unknown. If a chemical's fate and the mechanisms by which it causes adverse effects are known in both animals and humans, uncertainty is reduced. When the fate and mechanism for the chemical are unknown, uncertainty increases.

Conservative assumptions that incorporate UFs are used to extrapolate from animals to humans such that it is more likely that effects in humans are overestimated than underestimated. When data are available from several species, the highest dose that that does not cause effects in the most sensitive species is used to determine the NOAEL, which is used to calculate the RfD and the PAD. The PAD is calculated by dividing the NOAEL by UFs, generally of 1 to 10 each, to account for intraspecies variability, interspecies variability, and study duration. When using the NOAEL to calculate MOEs, the target MOE is typically 100 to account for intraspecies and interspecies variability. Generally, additional UFs for study duration are not required, because separate NOAELs are used for short-, intermediate-, and long-term exposures.

The use of the UFs compensates for uncertainties involved in extrapolating from animals to humans. Nevertheless, because the fate of a chemical can differ in animals and humans, it is possible that animal experiments will not reveal an adverse effect that would manifest itself in humans. This can result in an underestimation of the effects in humans. The opposite may also be true: effects observed in animals may not be observed in humans, resulting in an overestimation of potential adverse human health effects.

5.5.4 Availability of NOAELs

No Observable Adverse Effect Levels for all of the exposure durations and routes are not available for all of the herbicide a.i. In most cases, the USEPA did not develop specific NOAELs because the herbicide a.i. is not considered toxic through a specific exposure route. For example, there are no dermal NOAELs for diflufenzopyr because a dermal toxicity study did not show any effects at the limit dose of 1,000 mg/kg-day (USEPA 2002b). Therefore, risk calculations were not conducted for certain herbicide a.i. and certain exposure routes. It is likely that risks are not being underestimated because the specific exposure route is unlikely to show toxicity.

5.5.5 Exposure Assessment

There are uncertainties involved in the development of exposure scenarios and in the estimation of herbicide a.i. doses to which humans could be exposed.

5.5.5.1 Exposure Scenarios

Exposure scenarios in a risk evaluation are selected to be representative of current and reasonably foreseeable site use. In accordance with pesticide risk assessment approaches, both occupational and public (non-worker) receptors were

evaluated. The selection of occupational receptors considered the BLM's specific land programs, application types, application vehicles, and application methods. The occupational receptors include pilots, applicators, mixer/loaders, and combined applicator/mixer/loaders. Most occupational receptors are likely to have little herbicide a.i. exposure because of the use of PPE and other health and safety precautions. The accidental spill scenario evaluated for the occupational receptor is also very unlikely since a worker would take necessary precautions to prevent spills.

The HHRA evaluated a wide range of potential public receptors, including hiker/hunters, berry pickers, anglers, swimmers, nearby residents, and Native Americans. Although there are many different exposure scenarios and receptors that could be evaluated, these receptors cover a range of potential exposures that could occur under worst case conditions on public lands. It is assumed that these receptors could be exposed through a number of exposure pathways, such as herbicide spray, contact with sprayed foliage, contact with sprayed water through drinking or swimming, and ingestion of sprayed berries and fish that have bioaccumulated herbicide a.i. from sprayed water. Under the routine scenarios, receptors are assumed to be exposed to spray drift, while under the accidental scenarios, receptors are assumed to be exposed to direct spray. The Native American receptor is assumed to be exposed through all of these exposure pathways, which is likely to be a conservative assumption.

While it is possible that public receptors use public lands under intermediate- and long-term time frames, it is unlikely that public receptors would be exposed to herbicides under the routine use scenario for more than a short-term exposure, which is defined as 1 day to 1 month (USEPA 2001h). Therefore, a short-term scenario was evaluated in this HHRA. Although it is highly unlikely that public receptors would be potentially exposed to herbicides for longer than a short-term time frame, both an intermediate- and a long-term exposure scenario are evaluated in this Uncertainty Analysis. Appendix E presents the calculation of ARIs for the intermediate- and long-term exposure scenarios for the public receptors. The results of this analysis are discussed in Section 5.5.4.

5.5.5.2 Estimation of Dose

Various conservative assumptions were made to estimate the herbicide a.i. doses to which occupational and public receptors could be exposed. For the occupational receptors, exposure doses were estimated using UE information from the PHED, which is a generic database containing dermal and inhalation exposure data for workers mixing, loading, or applying pesticides. The USEPA has developed a series of standard UE values for various exposure scenarios, which were used in this HHRA. For the occupational worker accidental spill scenario, it was assumed that the herbicide a.i. could spill directly onto the worker and be absorbed through the skin. These exposure pathways are likely to result in conservative risk estimates.

For the public receptors, various conservative assumptions were used to estimate exposures. These exposure assumptions were generally derived from USEPA databases, such as the *EFH* (USEPA 1997a). The exposure assumptions listed in these guidance documents are generally conservative and default, and are meant to account for a wide range of exposure situations. To estimate exposures to the public from off-site deposition of herbicide a.i., the computer model AgDRIFT® was used (SDTF 2002). The AgDRIFT® Tier I and Tier II evaluations were used in this HHRA because they allow the development of routine generic application scenarios that are more representative of the range of applications likely employed by the BLM. The terrestrial DRs and water concentrations calculated by AgDRIFT® are likely to be upper-end estimates. The computer model GLEAMS was used to estimate runoff of the terrestrial herbicide a.i. into ponds. For the three terrestrial herbicide a.i., pond concentrations calculated in AgDRIFT® were added to the highest pond concentrations calculated in GLEAMS. This likely overestimates the true pond concentrations because AgDRIFT® concentrations represent relatively short duration concentrations. It is unlikely that a receptor would be exposed to pond water on the day that both drift concentrations and runoff concentrations are present.

Dicamba and diflufenzopyr are applied together in the herbicides Distinct® and Overdrive®. Overdrive® can be applied to rangeland at a maximum one-time AR of 8 ounces/acre/application but can be applied on a maximum seasonal basis of 10 ounces/acre. Distinct® can be applied to non-rangeland at a maximum AR of 8 ounces/acre. The 8 ounces/acre maximum was used to derive EPCs for both herbicides. Therefore, EPCs for dicamba on rangeland could be 25% higher than those estimated in the risk assessment. However, it is unlikely that including the subsequent

2 ounces/acre application would affect the risks substantially as the initial 8 ounce/acre application will have already started to dissipate in the environment. Thus, exposure to a full 10 ounces/acre application is highly unlikely.

Worst-case assumptions were made to evaluate the accidental spray and spill scenarios. The accidental spray scenario assumed that the receptor was exposed to direct spray at the maximum herbicide a.i. AR. The spill scenario assumed that a fully-loaded truck or helicopter emptied its contents into a pond while transporting the herbicide to the application site. In reality, the BLM requires that the herbicide be mixed at the application site; therefore, it is unlikely that premixed herbicide would be transported from one location to another. This scenario represents a worst-case scenario that is unlikely to occur.

5.5.6 Risk Characterization

The potential risk of adverse human health effects is characterized based on estimated potential exposures and potential dose-response relationships. Generally, the goal of a risk evaluation is to estimate a reasonable upper-bound to potential exposure and risk. Most of the assumptions about exposure and toxicity used in this evaluation are representative of statistical upper-bounds or even maxima for each parameter. The result of combining several such upper-bound assumptions is that the final estimate of potential exposure or potential risk is extremely conservative.

The health risks estimated in the risk characterization generally apply to the receptors whose activities and locations were described in the exposure assessment. Some people will always be more sensitive than the average person and, therefore, will be at greater risk. Dose-response values used to calculate risk, however, are frequently derived to account for additional sensitivity of subpopulations (e.g., an UF of 10 is used to account for intraspecies differences). Therefore, it is unlikely that this source of uncertainty contributes significantly to the overall uncertainty of the risk assessment.

The large number of assumptions made in the risk characterization introduces uncertainty in the results. Any one person's potential exposure and subsequent risk are influenced by all the parameters mentioned above and will vary on a case-by-case basis. Despite inevitable uncertainties associated with the steps used to derive potential risks, the use of numerous conservative (health-protective) assumptions will most likely lead to a large overestimate of potential risks from the site.

5.5.6.1 Public Receptors—Intermediate- and Long-term Exposure Scenarios

As stated previously, it is unlikely that public receptors would be potentially exposed to herbicides for more than a short-term exposure period. Although it is highly unlikely that public receptors would be potentially exposed to herbicides for longer than a short-term time frame, both an intermediate- and a long-term exposure scenarios are evaluated in this Uncertainty Analysis. While these exposures are extremely unlikely, they were included in the uncertainty anlaysis for completeness.

Dose response values for intermediate and long-term exposures are presented in Table 3-1. The exposure assumptions listed in Table 4-5 were used to evaluate the intermediate- and long-term exposure scenarios. EPCs for routine use intermediate- and long-term exposures were developed in Section 4.4.2. The DRs and the EPCs used to evaluate the routine use intermediate- and long-term exposure scenarios are presented in Tables 4-8 to 4-12. Appendix E presents risk calculation spreadsheets and summary ARI tables for public receptors under intermediate- and long-term exposure scenarios.

As indicated in Appendix E, routine use scenario ARIs for intermediate- and long-term exposure scenarios are greater than 1 under both the typical and maximum AR scenarios for all public receptors for dicamba, diflufenzopyr, imazapic, and sulfometuron methyl, indicating no level of concern. ARIs for diquat and fluridone are below one for the following intermediate- and long-term scenarios at the typical AR, indicating a level of concern:

Diquat

ARIs for diquat are below one for the following scenarios under the typical AR scenario (intermediate and long term), indicating a level of concern:

- Berry picker (child) – airplane and helicopter applications (intermediate- and long-term exposures)
- Residential (child) – airplane and helicopter applications (intermediate- and long-term exposures)
- Residential (adult) – airplane and helicopter applications (intermediate- and long-term exposures)
- Native American (child) – airplane and helicopter applications (intermediate- and long-term exposures)

ARIs for diquat are below 1 for the following scenarios under the maximum AR scenario (intermediate- and long-term), indicating a level of concern:

- Hiker/hunter (adult) – airplane and helicopter applications (intermediate- and long-term exposures)
- Berry picker (child) – Airplane and helicopter applications (intermediate- and long-term exposures), and high-boom applications (intermediate- and long-term exposures)
- Berry picker (adult) – Airplane and helicopter applications (intermediate- and long-term exposures)
- Angler (adult) – airplane and helicopter applications (intermediate- and long-term exposures)
- Residential (child) – airplane and helicopter applications (intermediate- and long-term exposures), low-boom applications (intermediate- and long-term exposures), and high-boom applications (intermediate- and long-term exposures)
- Residential (adult) – airplane and helicopter applications (intermediate- and long-term exposures), and high-boom applications (intermediate- and long-term exposures)
- Native American (child) – airplane and helicopter applications (intermediate- and long-term exposures), high-boom applications (intermediate- and long-term exposures)
- Native American (adult) – airplane and helicopter applications (intermediate- and long-term exposures)

Fluridone

Routine use scenario ARIs are greater than 1 under the typical AR scenario (intermediate and long term) for all public receptors, indicating no exceedance of the USEPA's level of concern. Routine use scenario ARIs are greater than 1 under the maximum AR scenario (intermediate term) for all public receptors, indicating no exceedance of the USEPA's level of concern. The following routine use scenario ARIs for fluridone are less than 1 under the maximum AR scenario (long term), indicating a level of concern:

- Nearby resident (child) – airplane applications and helicopter depositions
- Nearby resident (adult) – airplane applications

The results of evaluating the intermediate- and long-term exposures for the public receptors in the Uncertainty Analysis show that diquat in several scenarios and fluridone in very limited scenarios (resident, aerial application) could potentially pose a risk level of concern. The remaining herbicides do not pose a level of concern even under the unlikely scenario that public receptors could be repeatedly exposed to media that has received spray drift.

TABLE 5-1
Toxicity Values used in ARI Calculations

Scenario	Pathway	Toxicity Value for Aggregate Risk Index		
		Short Term	Intermediate Term	Long Term
Occupational	Inhalation	Short-term inhalation NOAEL	Intermediate-term Inhalation NOAEL	Long-term inhalation NOAEL
Occupational/Public	Dermal	Short-term dermal NOAEL	Intermediate-term dermal NOAEL	Long-term dermal NOAEL
Public	Oral (incidental ingestion and dermal for the swimming pathway)	Short/intermediate term oral NOAEL	Not applicable	Not applicable
Public	Dietary	Acute population adjusted dose	Not applicable	Not applicable

TABLE 5-2
Aggregate Risk Indices for Occupational Scenarios for Dicamba

Application Type	Application Vehicle	Application Method	Receptor[1]	Typical Application Rate Scenario Aggregate Risk Index			Maximum Application Rate Scenario Aggregate Risk Index			Accidental Scenario Aggregate Risk Index	
				Short Term	Intermediate Term	Long Term	Short Term	Intermediate Term	Long Term	Short Term (Dermal) Maximum	Short Term (Dermal) Typical
Ground	Human	Backpack	Applicator/mixer/loader	691	691	691	130	130	130	**0.16**	**0.21**
Ground	Human	Horseback	Applicator	598	598	598	252	252	252	**0.16**	**0.21**
Ground	Human	Horseback	Mixer/loader	8,029	8,029	8,029	3,387	3,387	3,387	**0.16**	**0.21**
Ground	Human	Horseback	Applicator/mixer/loader	557	557	557	235	235	235	**0.16**	**0.21**
Ground	ATV	Spot	Applicator	2,154	2,154	2,154	449	449	449	**0.16**	**0.21**
Ground	ATV	Spot	Mixer/loader	48,172	48,172	48,172	9,032	9,032	9,032	**0.16**	**0.21**
Ground	ATV	Spot	Applicator/mixer/loader	2,004	2,004	2,004	418	418	418	**0.16**	**0.21**
Ground	ATV	Boom/Broadcast	Applicator	14,789	14,789	14,789	3,081	3,081	3,081	**0.16**	**0.21**
Ground	ATV	Boom/Broadcast	Mixer/loader	15,054	15,054	15,054	3,387	3,387	3,387	**0.16**	**0.21**
Ground	ATV	Boom/Broadcast	Applicator/mixer/loader	5,607	5,607	5,607	1,168	1,168	1,168	**0.16**	**0.21**
Ground	Truck mount	Spot	Applicator	1,181	1,181	1,181	202	202	202	**0.16**	**0.21**
Ground	Truck mount	Spot	Mixer/loader	23,769	23,769	23,769	3,387	3,387	3,387	**0.16**	**0.21**
Ground	Truck mount	Spot	Applicator/mixer/loader	1,099	1,099	1,099	188	188	188	**0.16**	**0.21**
Ground	Truck mount	Boom/broadcast	Applicator	7,887	7,887	7,887	2,465	2,465	2,465	**0.16**	**0.21**
Ground	Truck mount	Boom/broadcast	Mixer/loader	8,029	8,029	8,029	2,007	2,007	2,007	**0.16**	**0.21**
Ground	Truck mount	Boom/broadcast	Applicator/mixer/loader	2,991	2,991	2,991	935	935	935	**0.16**	**0.21**

[1] Receptor scenarios are the same for each of the three programs because the typical and maximum acres treated per hour for each application type is the same for each program (See Table 4-1).
Shading and boldface indicates ARIs less than 1 and represent a level of concern.

TABLE 5-3
Aggregate Risk Indices for Occupational Scenarios for Diflufenzopyr

Application Type	Application Vehicle	Application Method	Receptor[1]	Typical Application Rate Scenario Aggregate Risk Index			Maximum Application Rate Scenario Aggregate Risk Index			Accidental Scenario Aggregate Risk Index
				Short Term	Intermediate Term	Long Term	Short Term	Intermediate Term	Long Term	Short Term (Dermal)
Ground	Human	Backpack	Applicator/mixer/loader	30,074	30,074	13,481	5,639	5,639	2,528	NC
Ground	Human	Horseback	Applicator	30,845	30,845	13,827	13,013	13,013	5,833	NC
Ground	Human	Horseback	Mixer/loader	100,247	100,247	44,938	42,292	42,292	18,958	NC
Ground	Human	Horseback	Applicator/mixer/loader	23,588	23,588	10,574	9,951	9,951	4,461	NC
Ground	ATV	Spot	Applicator	111,043	111,043	49,778	23,134	23,134	10,370	NC
Ground	ATV	Spot	Mixer/loader	601,481	601,481	269,630	112,778	112,778	50,556	NC
Ground	ATV	Spot	Applicator/mixer/loader	84,915	84,915	38,065	17,691	17,691	7,930	NC
Ground	ATV	Boom/broadcast	Applicator	182,883	182,883	81,982	38,101	38,101	17,080	NC
Ground	ATV	Boom/broadcast	Mixer/loader	187,963	187,963	84,259	42,292	42,292	18,958	NC
Ground	ATV	Boom/broadcast	Applicator/mixer/loader	69,759	69,759	31,271	14,533	14,533	6,515	NC
Ground	Truck mount	Spot	Applicator	60,879	60,879	27,290	10,410	10,410	4,667	NC
Ground	Truck mount	Spot	Mixer/loader	296,784	296,784	133,041	42,292	42,292	18,958	NC
Ground	Truck mount	Spot	Applicator/mixer/loader	46,554	46,554	20,869	7,961	7,961	3,569	NC
Ground	Truck mount	Boom/broadcast	Applicator	97,538	97,538	43,724	30,480	30,480	13,664	NC
Ground	Truck mount	Boom/broadcast	Mixer/loader	100,247	100,247	44,938	25,062	25,062	11,235	NC
Ground	Truck mount	Boom/broadcast	Applicator/mixer/loader	37,205	37,205	16,678	11,627	11,627	5,212	NC

[1] Receptor scenarios are the same for each of the three programs because the typical and maximum acres treated per hour for each application type are the same for each program (See Table 4-1).
NC = Not calculated. No dermal effects identified in laboratory tests.
Aggregate risk index values less than 1 represent a level of concern.

TABLE 5-4
Aggregate Risk Indices for Occupational Scenarios for Diquat

Application Type	Application Vehicle	Application Method	Receptor	Typical Application Rate Scenario Aggregate Risk Index			Maximum Application Rate Scenario Aggregate Risk Index			Accidental Scenario Aggregate Risk Index (Short-Term Dermal)		
				Short Term	Intermediate Term	Long Term	Short Term	Intermediate Term	Long Term	Concentrated Solution[1]	Mixed (Maximum) Solution[2]	Mixed (Typical) Solution[3]
Aerial	Plane	Fixed wing	Pilot	**0.239**	**0.232**	**0.232**	**0.020**	**0.019**	**0.019**	**0.0003**	**0.001**	**0.003**
Aerial	Plane	Fixed wing	Mixer/loader	**0.014**	**0.013**	**0.013**	**0.001**	**0.001**	**0.001**	**0.0003**	**0.001**	**0.003**
Aerial	Helicopter	Rotary	Pilot	**0.599**	**0.581**	**0.581**	**0.050**	**0.048**	**0.048**	**0.0003**	**0.001**	**0.003**
Aerial	Helicopter	Rotary	Mixer/loader	**0.034**	**0.034**	**0.034**	**0.003**	**0.003**	**0.003**	**0.0003**	**0.001**	**0.003**
Ground	Human	Backpack	Applicator/mixer/loader	**0.863**	**0.802**	**0.802**	**0.054**	**0.050**	**0.050**	**0.0003**	**0.001**	**0.003**
Ground	Human	Horseback	Applicator	**0.872**	**0.800**	**0.800**	**0.123**	**0.112**	**0.112**	**0.0003**	**0.001**	**0.003**
Ground	Human	Horseback	Mixer/loader	3.054	2.998	2.998	**0.429**	**0.422**	**0.422**	**0.0003**	**0.001**	**0.003**
Ground	Human	Horseback	Applicator/mixer/loader	**0.678**	**0.631**	**0.631**	**0.095**	**0.089**	**0.089**	**0.0003**	**0.001**	**0.003**
Ground	ATV	Spot	Applicator	3.137	2.879	2.879	**0.218**	**0.200**	**0.200**	**0.0003**	**0.001**	**0.003**
Ground	ATV	Spot	Mixer/loader	18.321	17.988	17.988	1.145	1.124	1.124	**0.0003**	**0.001**	**0.003**
Ground	ATV	Spot	Applicator/mixer/loader	2.441	2.273	2.273	**0.169**	**0.158**	**0.158**	**0.0003**	**0.001**	**0.003**
Ground	ATV	Boom/broadcast	Applicator	5.572	5.472	5.472	**0.387**	**0.380**	**0.380**	**0.0003**	**0.001**	**0.003**
Ground	ATV	Boom/broadcast	Mixer/loader	5.725	5.621	5.621	**0.429**	**0.422**	**0.422**	**0.0003**	**0.001**	**0.003**
Ground	ATV	Boom/broadcast	Applicator/mixer/loader	2.125	2.087	2.087	**0.148**	**0.145**	**0.145**	**0.0003**	**0.001**	**0.003**
Ground	Truck mount	Spot	Applicator	1.720	1.579	1.579	**0.098**	**0.090**	**0.090**	**0.0003**	**0.001**	**0.003**
Ground	Truck mount	Spot	Mixer/loader	9.040	8.876	8.876	**0.429**	**0.422**	**0.422**	**0.0003**	**0.001**	**0.003**
Ground	Truck mount	Spot	Applicator/mixer/loader	1.338	1.246	1.246	**0.076**	**0.071**	**0.071**	**0.0003**	**0.001**	**0.003**
Ground	Truck mount	Boom/broadcast	Applicator	2.972	2.918	2.918	**0.310**	**0.304**	**0.304**	**0.0003**	**0.001**	**0.003**
Ground	Truck mount	Boom/broadcast	Mixer/loader	3.054	2.998	2.998	**0.254**	**0.250**	**0.250**	**0.0003**	**0.001**	**0.003**
Ground	Truck mount	Boom/broadcast	Applicator/mixer/loader	1.133	1.113	1.113	**0.118**	**0.116**	**0.116**	**0.0003**	**0.001**	**0.003**
Aquatic	Boat	Spot	Applicator	25.108	12.554	12.554	16.738	8.369	8.369	**0.0003**	**0.001**	**0.003**
Aquatic	Boat	Spot	Mixer/loader	36.326	18.163	18.163	18.163	9.081	9.081	**0.0003**	**0.001**	**0.003**
Aquatic	Boat	Spot	Applicator/mixer/loader	6.669	3.335	3.335	4.446	2.223	2.223	**0.0003**	**0.001**	**0.003**
Aquatic	Boat	Boom/broadcast	Applicator	25.108	12.554	12.554	16.738	8.369	8.369	**0.0003**	**0.001**	**0.003**
Aquatic	Boat	Boom/broadcast	Mixer/loader	36.326	18.163	18.163	18.163	9.081	9.081	**0.0003**	**0.001**	**0.003**
Aquatic	Boat	Boom/broadcast	Applicator/mixer/loader	6.669	3.335	3.335	4.446	2.223	2.223	**0.0003**	**0.001**	**0.003**

[1] Based on the assumption that a spill of concentrated liquid occurs.
[2] Based on the assumption that a spill occurs after concentrated liquid is mixed with water to the maximum application rate.
[3] Based on the assumption that a spill occurs after concentrated liquid is mixed with water to the typical application rate.
Shading and boldface indicates ARIs less than 1 and represent a level of concern.

TABLE 5-5
Aggregate Risk Indices for Occupational Scenarios for Fluridone

Application Type	Application Vehicle	Application Method	Receptor	Typical Application Rate Scenario Aggregate Risk Index			Maximum Application Rate Scenario Aggregate Risk Index			Accidental Scenario Aggregate Risk Index (Short-Term Dermal)		
				Short Term	Intermediate Term	Long Term	Short Term	Intermediate Term	Long Term	Concentrated Solution[1]	Mixed (Maximum) Solution[2]	Mixed (Typical) Solution[3]
Aerial	Plane	Fixed Wing	Pilot	225	45	14	24	5	2	**0.002**	**0.03**	**0.1**
Aerial	Plane	Fixed Wing	Mixer/loader	21	4	1	2	**0.43**	**0.14**	**0.002**	**0.03**	**0.1**
Aerial	Helicopter	Rotary	Pilot	563	113	36	59	12	4	**0.002**	**0.03**	**0.1**
Aerial	Helicopter	Rotary	Mixer/loader	51	10	3	5	1	**0.35**	**0.002**	**0.03**	**0.1**
Ground	Human	Backpack	Applicator/mixer/loader	345	69	22	27	5	2	**0.002**	**0.03**	**0.1**
Ground	Human	Horseback	Applicator	297	59	19	53	11	3	**0.002**	**0.03**	**0.1**
Ground	Human	Horseback	Mixer/loader	4,560	912	292	809	162	52	**0.002**	**0.03**	**0.1**
Ground	Human	Horseback	Applicator/mixer/loader	278	56	18	49	10	3	**0.002**	**0.03**	**0.1**
Ground	ATV	Spot	Applicator	1,068	214	68	94	19	6	**0.002**	**0.03**	**0.1**
Ground	ATV	Spot	Mixer/loader	27,361	5,472	1,751	2,157	431	138	**0.002**	**0.03**	**0.1**
Ground	ATV	Spot	Applicator/mixer/loader	1,003	201	64	88	18	6	**0.002**	**0.03**	**0.1**
Ground	ATV	Boom/vroadcast	Applicator	8,415	1,683	539	737	147	47	**0.002**	**0.03**	**0.1**
Ground	ATV	Boom/broadcast	Mixer/loader	8,550	1,710	547	809	162	52	**0.002**	**0.03**	**0.1**
Ground	ATV	Boom/broadcast	Applicator/mixer/loader	3,187	637	204	279	56	18	**0.002**	**0.03**	**0.1**
Ground	Truck mount	Spot	Applicator	585	117	37	42	8	3	**0.002**	**0.03**	**0.1**
Ground	Truck mount	Spot	Mixer/loader	13,500	2,700	864	809	162	52	**0.002**	**0.03**	**0.1**
Ground	Truck mount	Spot	Applicator/mixer/loader	550	110	35	40	8	3	**0.002**	**0.03**	**0.1**
Ground	Truck mount	Boom/broadcast	Applicator	4,488	898	287	590	118	38	**0.002**	**0.03**	**0.1**
Ground	Truck mount	Boom/broadcast	Mixer/loader	4,560	912	292	479	96	31	**0.002**	**0.03**	**0.1**
Ground	Truck mount	Boom/broadcast	Applicator/mixer/loader	1,700	340	109	223	45	14	**0.002**	**0.03**	**0.1**
Aquatic	Boat	Boom/broadcast (granular)	Applicator	1,914	383	122	434	87	28	**0.002**	**0.03**	**0.1**
Aquatic	Boat	Boom/broadcast (granular)	Mixer/loader	1,914	383	122	434	87	28	**0.002**	**0.03**	**0.1**
Aquatic	Boat	Boom/broadcast (granular)	Applicator/mixer/loader	1,914	383	122	434	87	28	**0.002**	**0.03**	**0.1**
Aquatic	Boat	Boom/broadcast (liquid)	Applicator	684	137	44	41	8	3	**0.002**	**0.03**	**0.1**
Aquatic	Boat	Boom/broadcast (liquid)	Mixer/loader	684	137	44	151	30	10	**0.002**	**0.03**	**0.1**
Aquatic	Boat	Boom/broadcast (liquid)	Applicator/mixer/loader	684	137	44	151	30	10	**0.002**	**0.03**	**0.1**

[1] Based on the assumption that a spill of concentrated liquid occurs.
[2] Based on the assumption that a spill occurs after concentrated liquid is mixed with water to the maximum application rate.
[3] Based on the assumption that a spill occurs after concentrated liquid is mixed with water to the typical application rate.
Shading and boldface indicates ARIs less than 1 and represent a level of concern.

TABLE 5-6
Aggregate Risk Indices for Occupational Scenarios for Imazapic

Application Type	Application Vehicle	Application Method	Receptor[1]	Typical Application Rate Scenario Aggregate Risk Index			Maximum Application Rate Scenario Aggregate Risk Index			Accidental Scenario Aggregate Risk Index
				Short Term[2]	Intermediate Term[2]	Long Term	Short Term[2]	Intermediate Term[2]	Long Term	Short Term (Dermal)
Aerial	Plane	Fixed Wing	Pilot	116,224	116,224	883	6,321	6,321	48	NC
Aerial	Plane	Fixed Wing	Mixer/loader	6,586	6,586	81	358	358	4	NC
Aerial	Helicopter	Rotary	Pilot	290,560	290,560	2,207	15,802	15,802	120	NC
Aerial	Helicopter	Rotary	Mixer/loader	16,465	16,465	203	895	895	11	NC
Ground	Human	Backpack	Applicator/mixer/loader	439,068	439,068	1,343	17,909	17,909	55	NC
Ground	Human	Horseback	Applicator	450,326	450,326	1,152	41,329	41,329	106	NC
Ground	Human	Horseback	Mixer/loader	1,463,560	1,463,560	18,043	134,320	134,320	1,656	NC
Ground	Human	Horseback	Applicator/mixer/loader	344,367	344,367	1,083	31,605	31,605	99	NC
Ground	ATV	Spot	Applicator	1,621,175	1,621,175	4,148	73,474	73,474	188	NC
Ground	ATV	Spot	Mixer/loader	8,781,362	8,781,362	108,261	358,187	358,187	4,416	NC
Ground	ATV	Spot	Applicator/mixer/loader	1,239,722	1,239,722	3,899	56,186	56,186	177	NC
Ground	ATV	Boom/broadcast	Applicator	2,670,009	2,670,009	33,307	121,009	121,009	1,510	NC
Ground	ATV	Boom/broadcast	Mixer/loader	2,744,176	2,744,176	33,831	134,320	134,320	1,656	NC
Ground	ATV	Boom/broadcast	Applicator/mixer/loader	1,018,457	1,018,457	12,612	46,158	46,158	572	NC
Ground	Truck Mount	Spot	Applicator	888,802	888,802	2,274	33,063	33,063	85	NC
Ground	Truck Mount	Spot	Mixer/loader	4,332,909	4,332,909	53,418	134,320	134,320	1,656	NC
Ground	Truck Mount	Spot	Applicator/mixer/loader	679,672	679,672	2,137	25,284	25,284	80	NC
Ground	Truck Mount	Boom/broadcast	Applicator	1,424,005	1,424,005	17,764	96,807	96,807	1,208	NC
Ground	Truck Mount	Boom/broadcast	Mixer/loader	1,463,560	1,463,560	18,043	79,597	79,597	981	NC
Ground	Truck Mount	Boom/broadcast	Applicator/mixer/loader	543,177	543,177	6,727	36,927	36,927	457	NC

[1] Receptor scenarios are the same for each of the five programs as the typical and maximum acres treated per hour for each application type is the same for each program (See Table 4-1).
[2] Receptor scenarios are the same for each of the five programs as the typical and maximum acres treated per hour for each application type is the same for each program (See Table 4-1).
NC = Not calculated. Short-term dermal toxicity was not demonstrated in laboratory studies even at high doses.
Short- and intermediate-term ARIs are based on the inhalation pathway. No short- or intermediate-term dermal NOAELs are available as no toxicity was demonstrated in laboratory tests at high doses.
Long-term ARIs are based on both dermal and inhalation pathways.
Aggregate risk index values less than 1 represent a level of concern.

TABLE 5-7
Aggregate Risk Indices for Occupational Scenarios for Sulfometuron Methyl

Application Type	Application Vehicle	Application Method	Receptor[1]	Typical Application Rate Scenario Aggregate Risk Index[2]			Maximum Application Rate Scenario Aggregate Risk Index[2]			Accidental Scenario Aggregate Risk Index
				Short Term	Intermediate Term	Long Term	Short Term	Intermediate Term	Long Term	Short Term (Dermal)
Aerial	Helicopter[3]	Rotary	Pilot	919	919	919	113	113	113	NC
Aerial	Helicopter[3]	Rotary	Mixer/loader	52	52	52	6	6	6	NC
Ground	Human	Backpack	Applicator/mixer/loader	1,389	1,389	1,389	128	128	128	NC
Ground	Human	Horseback	Applicator	1,425	1,425	1,425	295	295	295	NC
Ground	Human	Horseback	Mixer/loader	4,630	4,630	4,630	959	959	959	NC
Ground	Human	Horseback	Applicator/mixer/loader	1,089	1,089	1,089	226	226	226	NC
Ground	ATV	Spot	Applicator	5,128	5,128	5,128	525	525	525	NC
Ground	ATV	Spot	Mixer/loader	27,778	27,778	27,778	2,558	2,558	2,558	NC
Ground	ATV	Spot	Applicator/mixer/loader	3,922	3,922	3,922	401	401	401	NC
Ground	ATV	Boom/broadcast	Applicator	8,446	8,446	8,446	864	864	864	NC
Ground	ATV	Boom/broadcast	Mixer/loader	8,681	8,681	8,681	959	959	959	NC
Ground	ATV	Boom/broadcast	Applicator/mixer/loader	3,222	3,222	3,222	330	330	330	NC
Ground	Truck mount	Spot	Applicator	2,812	2,812	2,812	236	236	236	NC
Ground	Truck mount	Spot	Mixer/loader	13,706	13,706	13,706	959	959	959	NC
Ground	Truck mount	Spot	Applicator/mixer/loader	2,150	2,150	2,150	181	181	181	NC
Ground	Truck mount	Boom/broadcast	Applicator	4,505	4,505	4,505	691	691	691	NC
Ground	Truck mount	Boom/broadcast	Mixer/loader	4,630	4,630	4,630	569	569	569	NC
Ground	Truck mount	Boom/broadcast	Applicator/mixer/loader	1,718	1,718	1,718	264	264	264	NC

[1] Receptor scenarios are the same for each of the three programs as the typical and maximum acres treated per hour for each application type is the same for each program (See Table 4-1).
[2] ARIs are based on the inhalation pathway. No dermal toxicity identified in laboratory tests.
[3] Helicopter pathway applicable to public domain forestland, energy/mineral and ROW sites only. Not used on recreation and cultural sites.
NC = Not calculated. Short-term dermal toxicity was not demonstrated in laboratory studies even at high doses.
Aggregate risk index values less than 1 represent a level of concern.

TABLE 5-8
Aggregate Risk Indices for Routine Short-term Exposure Scenarios for Public Receptors for Dicamba

AgDRIFT® Scenario:	Typical Application Rate Scenario ARIs[1,2]		Maximum Application Rate Scenario ARIs[1,2]	
	Ground	Ground	Ground	Ground (Truck or ATV)
Land Type:	NA	NA	NA	NA
Equipment[3]:	Low Boom	High Boom	Low Boom	High Boom
Hiker/hunter (adult)	655	518	428	347
Berry picker (child)	316	260	203	171
Berry picker (adult)	634	497	416	335
Angler (adult)	425	363	269	235
Residential (child)	457	277	343	207
Residential (adult)	758	459	568	344
Native American (child)	73	69	44	43
Native American (adult)	78	76	48	46
Swimmer (child)	4,220	4,210	2,534	2,529
Swmmer (adult)	19,566	19,518	11,749	11,726

[1] ARIs are based on dermal, oral and dietary exposure.
[2] Application rates are shown on Table 4-1 and are the same for each program.
[3] Low and high boom applies to a truck-mount or an all-terrain vehicle (ATV)-mount boom
NA = Not applicable.
Aggregate risk index values less than 1 represent a level of concern.

TABLE 5-9
Aggregate Risk Indices for Accidental Exposure Scenarios for Public Receptors Based on Maximum Herbicide Application Rates for Dicamba[1]

Receptor	Dermal Contact Exposure Pathways				Dietary Exposure Pathways				
	Direct Spray of Receptor	Dermal Contact with Foliage	Swimming[2]		Drinking Water Ingestion		Fish Ingestion		Berry Ingestion
			Water Body Spray	Truck Spill[3]	Water Body Spray	Truck Spill[3]	Water Body Spray	Truck Spill[3]	
Angler (adult)	17	187	NA	NA	1,247	39	1,375	43	NA
Berry picker (adult)	17	125	NA	NA	1,247	39	NA	NA	390
Berry picker (child)	10	134	NA	NA	534	17	NA	NA	388
Hiker/hunter (adult)	17	187	NA	NA	1,247	39	NA	NA	NA
Native American (adult)	17	83	839,223	26,226	2,494	78	98	3	390
Native American (child)	10	89	490,455	15,327	1,069	33	98	3	388
Residential (adult)	17	13	NA	NA	NA	NA	NA	NA	390
Residential (child)	10	8	NA	NA	NA	NA	NA	NA	388
Swimmer (adult)	NA	NA	22,216	694	NA	NA	NA	NA	NA
Swimmer (child)	NA	NA	4,791	150	NA	NA	NA	NA	NA

[1] Maximum application rate is shown in Table 4-1 and applies to all dicamba application methods.
[2] Includes incidental ingestion for the swimmer.
[3] Dicamba is applied via ground methods only. Therefore, the helicopter scenario is not evaluated.
NA = Receptor not exposed via this pathway.
Aggregate risk index values less than 1 represent a level of concern.

TABLE 5-10
Aggregate Risk Indices for Routine Short-term Exposure Scenarios for Public Receptors for Diflufenzopyr

	Typical Application Rate Scenario ARIs[1,2]		Maximum Application Rate Scenario ARIs[1,2]	
AgDRIFT® Scenario:	**Ground**	**Ground**	**Ground**	**Ground (Truck or ATV)**
Land Type:	**NA**	**NA**	**NA**	**NA**
Equipment[3]:	**Low Boom**	**High Boom**	**Low Boom**	**High Boom**
Hiker/hunter (adult)	2,810	2,803	2,107	2,102
Berry picker (child)	1,190	1,178	893	884
Berry picker (adult)	2,735	2,683	2,052	2,012
Angler (Adult)	2,555	2,549	1,917	1,912
Residential (child)	102,543	62,112	77,089	46,650
Residential (adult)	103,184	62,500	77,571	46,942
Native American (child)	1,080	1,070	810	802
Native American (adult)	1,456	1,439	1,092	1,080
Swimmer (child)	13,781	13,747	10,336	10,310
Swimmer (adult)	62,849	62,693	47,136	47,021

[1] ARIs are based on oral and dietary exposure. Based on laboratory studies, diflufenzopyr does not have toxic effects via the dermal route of exposure.
[2] Application rates are shown in Table 4-1 and are the same for each program.
[3] Low and high boom apply to a truck-mount or an all-terrain vehicle (ATV)-mount boom.
NA = Receptor not exposed via this pathway.
Aggregate risk index values less than 1 represent a level of concern.

TABLE 5-11
Aggregate Risk Indices for Accidental Exposure Scenarios for Public Receptors Based on Maximum Herbicide Application Rates for Diflufenzopyr[1]

Receptor	Dermal Contact Exposure Pathways				Dietary Exposure Pathways				
	Direct Spray of Receptor	Dermal Contact with Foliage	Swimming[2]		Drinking Water Ingestion		Fish Ingestion		Berry Ingestion
			Water Body Spray	Truck Spill[3]	Water Body Spray	Truck Spill[3]	Water Body Spray	Truck Spill[3]	
Angler (adult)	NC	NC	NA	NA	3,117	97	31,317	979	NA
Berry picker (adult)	NC	NC	NA	NA	3,117	97	NA	NA	975
Berry picker (child)	NC	NC	NA	NA	1,336	42	NA	NA	969
Hiker/hunter (adult)	NC	NC	NA	NA	3,117	97	NA	NA	NA
Native American (adult)	NC	NC	746,997	23,344	6,235	195	2,229	70	975
Native American (child)	NC	NC	436,557	13,642	2,672	83	2,225	70	969
Residential (adult)	NC	NC	NA	NA	NA	NA	NA	NA	975
Residential (child)	NC	NC	NA	NA	NA	NA	NA	NA	969
Swimmer (adult)	NA	NA	69,725	2,179	NA	NA	NA	NA	NA
Swimmer (child)	NA	NA	15,289	478	NA	NA	NA	NA	NA

[1] Includes incidental ingestion for the swimmer.
[2] Maximum application rate is shown in Table 4-1 and applies to all diflufenzopyr application methods.
[3] Diflufenzopyr is applied via ground methods only. Therefore, the helicopter scenario is not evaluated.
NA = Receptor not exposed via this pathway.
NC = Not calculated. Dermal toxicity was not demonstrated in laboratory studies, even at high doses.
Aggregate risk index values less than 1 represent a level of concern.

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TABLE 5-12
Aggregate Risk Indices for Routine Short-term Exposure Scenarios for Public Receptors for Diquat

AgDRIFT® Scenario:	Typical Application Rate Scenario ARIs[1,2]				Maximum Application Rate Scenario ARIs[1,2]			
	Aerial	Aerial	Ground	Ground	Aerial	Aerial	Ground	Ground
Land Type[3]:	Agricultural	Agricultural	Agricultural	Agricultural	Agricultural	Agricultural	Agricultural	Agricultural
Equipment[4]:	Plane	Helicopter	Low Boom	High Boom	Plane	Helicopter	Low Boom	High Boom
Hiker/hunter (adult)	3.162	3.479	34.787	17.397	**0.682**	**0.791**	5.800	3.866
Berry picker (child)	1.918	2.110	21.102	10.554	**0.414**	**0.480**	3.519	2.346
Berry picker (adult)	3.026	3.329	33.289	16.647	**0.653**	**0.757**	5.550	3.700
Angler (adult)	3.162	3.479	34.786	17.396	**0.682**	**0.791**	5.799	3.866
Residential (child)	**0.901**	**0.991**	9.911	4.955	**0.194**	**0.225**	1.652	1.101
Residential (adult)	1.503	1.654	16.537	8.268	**0.324**	**0.376**	2.756	1.837
Native American (child)	1.855	2.040	20.404	10.204	**0.400**	**0.464**	3.402	2.268
Native American (adult)	2.859	3.145	31.451	15.728	**0.617**	**0.715**	5.243	3.495
Swimmer (child)	371.283	439.878	4398.782	2752.265	77.120	92.878	1098.890	684.924
Swimmer (adult)	1732.625	2052.729	20527.285	12843.677	359.887	433.424	5128.062	3196.258

[1] Application rates are shown in Table 4-1.
[2] ARIs are based on oral, dermal, and dietary exposure.
[3] AgDRIFT® was used to predict spray drift deposition onto a pond. Agricultural land type is used as a proxy for a pond for aerial scenarios. Ground scenarios are not differentiated in AgDRIFT® by land type.
[4] Low and high boom apply to a truck-mount or an all-terrain vehicle (ATV)-mount boom.
ARI = Aggregate risk index. Values less than 1 represent a level of concern. Shading and boldface indicates ARIs less than 1.

TABLE 5-13
Aggregate Risk Indices for Accidental Exposure Scenarios for Public Receptors Based on Maximum Herbicide Application Rates for Diquat[1]

Receptor	Dermal Contact Exposure Pathways					Dietary Exposure Pathways						
	Direct Spray of Receptor	Dermal Contact with Foliage	Swimming[2]			Drinking Water Ingestion			Fish Ingestion			Berry Ingestion
			Water Body Spray[3]	Helicopter Spill	Truck Spill	Water Body Spray	Helicopter Spill	Truck Spill	Water Body Spray[3]	Helicopter Spill	Truck Spill	
Angler (adult)	**0.085**	**0.952**	NA	NA	NA	58.45	**0.52**	1.83	1,801.48	16.08	56.30	NA
Berry picker (adult)	**0.085**	**0.634**	NA	NA	NA	58.45	**0.52**	1.83	NA	NA	NA	18.29
Berry picker (child)	**0.051**	**0.680**	NA	NA	NA	25.05	**0.22**	**0.78**	NA	NA	NA	18.17
Hiker/hunter (adult)	**0.085**	**0.952**	NA	NA	NA	58.45	**0.52**	1.83	NA	NA	NA	NA
Native American (adult)	**0.085**	**0.423**	428,668.07	3,827.39	13,395.88	116.90	1.04	3.65	128.24	1.15	4.01	18.29
Native American (child)	**0.051**	**0.453**	250,520.30	2,236.79	7,828.76	50.10	**0.45**	1.57	128.00	1.14	4.00	18.17
Residential (adult)	**0.085**	**0.066**	NA	NA	NA	NA	NA	NA	NA	NA	NA	18.29
Residential (child)	**0.051**	**0.039**	NA	NA	NA	NA	NA	NA	NA	NA	NA	18.17
Swimmer (adult)	NA	NA	31.17	**0.28**	**0.97**	NA	NA	NA	NA	NA	NA	NA
Swimmer (child)	NA	NA	6.68	**0.06**	**0.21**	NA	NA	NA	NA	NA	NA	NA

[1] Maximum application rate is shown in Table 4-1 and applies to all diquat application methods.
[2] Includes incidental ingestion for the swimmer.
[3] Re-entry to a treated pond for swimming, fishing, or drinking water.
NA = Receptor not exposed via this pathway.
NC = Not calculated. Dermal toxicity was not demonstrated in laboratory studies, even at high doses.
ARI = Aggregate risk index. Values less than 1 represent a level of concern. Shading and boldface indicates ARIs less than 1.

TABLE 5-14
Aggregate Risk Indices for Accidental Exposure Scenarios Based on Typical Herbicide Application Rates for Diquat[1,2]

Receptor	Dermal Contact Exposure Pathways				Dietary Exposure Pathways	
	Direct Spray of Receptor	Dermal Contact with Foliage	Swimming[3]		Drinking Water Ingestion	
			Helicopter Spill	Truck Spill	Helicopter Spill	Truck Spill
Angler (adult)	**0.338**	3.806	NA	NA	2.09	[4]
Berry picker (adult)	**0.338**	2.538	NA	NA	2.09	[4]
Berry picker (child)	**0.203**	2.719	NA	NA	**0.89**	3.13
Hiker/hunter (adult)	**0.338**	3.806	NA	NA	2.09	[4]
Native American (adult)	**0.338**	1.692	[4]	[4]	[4]	[4]
Native American (child)	**0.203**	1.813	[4]	[4]	1.79	[4]
Residential (adult)	**0.338**	**0.263**	NA	NA	NA	NA
Residential (child)	**0.203**	**0.157**	NA	NA	NA	NA
Swimmer (adult)	NA	NA	1.11	3.90	NA	NA
Swimmer (child)	NA	NA	**0.24**	**0.83**	NA	NA

[1] Scenarios and Receptor combinations shown on this table have ARIs below one under the maximum application rate scenario. Scenarios with ARIs greater than one under the maximum application rate scenario are not shown here.
[2] Typical application rate is shown in Table 4-1 and applies to all diquat application methods.
[3] Includes incidental ingestion for the swimmer.
[4] ARI is greater than 1 under the maximum application rate scenario. Therefore, typical application scenario not conducted.
NA = Receptor not exposed via this pathway.
NC = Not calculated. No dose-response values available.
ARI = Aggregate risk index. Values less than 1 represent a level of concern. Shading and boldface indicates ARIs less than 1.

TABLE 5-15
Aggregate Risk Indices for Routine Short-term Exposure Scenarios for Public Receptors for Fluridone

AgDRIFT® Scenario:	Typical Application Rate Scenario ARIs[1,2]				Maximum Application Rate Scenario ARIs[1,2]			
	Aerial	Aerial	Ground	Ground	Aerial	Aerial	Ground	Ground
Land Type[3]:	Agricultural	Agricultural	Agricultural	Agricultural	Agricultural	Agricultural	Agricultural	Agricultural
Equipment:	Plane	Helicoptor	Low boom[4]	High boom[4]	Plane	Helicoptor	Low Boom[4]	High Boom[4]
Hiker/hunter (adult)	112	112	773	468	30	34	223	149
Berry picker (child)	14	14	94	57	3.6	4.2	27	18
Berry picker (adult)	107	107	743	449	29	33	214	143
Angler (adult)	112	112	773	468	30	34	223	149
Residential (child)	6.4	6.4	44	27	1.7	2.0	12.7	8.5
Residential (adult)	53	53	368	223	14.2	16.3	106	71
Native American (child)	13	13	91	55	3.5	4.0	26	17
Native American (adult)	101	101	701	424	27	31	202	135
Swimmer (child)	24,239	28,506	255,426	158,717	6,307	7,565	78,055	48,479
Swimmer (adult)	104,156	122,487	1,097,553	681,999	27,099	32,507	335,397	208,311

[1] Application rates are shown in Table 4-1 and are the same for each program.
[2] Short-term ARIs are based on dermal and incidental oral exposure. No acute dietary toxicity value available because fluridone does not have acute dietary effects.
[3] AgDRIFT® was used to predict spray drift deposition onto a pond. Agricultural land type is used as a proxy for a pond for aerial scenarios. Ground scenarios are not differentiated in AgDRIFT® by land type.
[4] Low and high boom apply to a truck-mount or an all-terrain vehicle (ATV)-mount boom.
Aggregate risk index values less than 1 represent a level of concern.

TABLE 5-16
Aggregate Risk Indices for Accidental Exposure Scenarios for Public Receptors Based on Maximum Herbicide Application Rates for Fluridone[1]

Receptor	Dermal Contact Exposure Pathways					Dietary Exposure Pathways						
	Direct Spray of Receptor	Dermal Contact with Foliage	Swimming[2]			Drinking Water Ingestion			Fish Ingestion			Berry Ingestion
			Water Body Spray[3]	Helicopter Spill	Truck Spill	Water Body Spray	Helicopter Spill	Truck Spill	Water Body Spray[3]	Helicopter Spill	Truck Spill	
Angler (adult)	3.3	38	NA	NA	NA	NC	NC	NC	NC	NC	NC	NA
Berry picker (adult)	3.3	25	NA	NA	NA	NC	NC	NC	NA	NA	NA	NC
Berry picker (child)	**0.4**	5.4	NA	NA	NA	NC	NC	NC	NA	NA	NA	NC
Hiker/hunter (adult)	3.3	38	NA	NA	NA	NC	NC	NC	NA	NA	NA	NA
Native American (adult)	3.3	17	6,450	58	202	NC	NC	NC	NA	NA	NA	NA
Native American (child)	**0.4**	3.6	3,770	34	118	NC	NC	NC	NC	NC	NC	NC
Residential (adult)	3.3	2.6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NC
Residential (child)	**0.4**	**0.3**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NC
Swimmer (adult)	NA	NA	2,098	19	66	NA	NA	NA	NA	NA	NA	NA
Swimmer (child)	NA	NA	488	4	15	NA	NA	NA	NA	NA	NA	NA

[1] Maximum application rate is shown in Table 4-1 and applies to all fluridone application methods.
[2] Includes incidental ingestion for the swimmer.
[3] Re-entry to a treated pond for swimming, fishing, or drinking water.
NA = Receptor not exposed via this pathway.
NC = Not calculated. Fluridone does not have acute dietary effects.
ARI = Aggregate risk index. Values less than 1 represent a level of concern. Shading and boldface indicates ARIs less than 1.

TABLE 5-17
Aggregate Risk Indices for Accidental Exposure Scenarios Based on Typical Herbicide Application Rates for Fluridone[1,2]

Receptor	Dermal Contact Exposure Pathways	
	Direct Spray of Receptor	Dermal Contact with Foliage
Berry picker (child)	1.3	[3]
Native American (child)	1.3	[3]
Residential (child)	1.3	1.0

[1] Scenarios and receptor combinations shown on this table have ARIs below 1 under the maximum application rate scenario. Scenarios with ARIs greater than 1 under the maximum application rate scenario are not shown here.
[2] Typical application rate is shown in Table 4-1 and applies to all fluridone application methods.
[3] The ARI is greater than one under the maximum application rate scenario; therefore, the typical application scenario was not conducted.
Aggregate risk index values less than 1 represent a level of concern.

TABLE 5-18
Aggregate Risk Indices for Routine Short-term Exposure Scenarios for Public Receptors for Imazapic

	Typical Application Rate Scenario ARIs[1,2]						Maximum Application Rate Scenario ARIs[1,2]					
AgDRIFT® Scenario:	**Aerial**	**Aerial**	**Aerial**	**Aerial**	**Ground**	**Ground**	**Aerial**	**Aerial**	**Aerial**	**Aerial**	**Ground**	**Ground**
Land Type[3]:	**Agricul[4]**	**Agricul**	**Forestry**	**Forestry**	**NA**	**NA**	**Agricul**	**Agricul**	**Forestry**	**Forestry**	**NA**	**NA**
Equipment[5]:	**Plane**	**Helicopter**	**Plane**	**Helicopter**	**Low Boom**	**High Boom**	**Plane**	**Helicopter**	**Plane**	**Helicopter**	**Low Boom**	**High Boom**
Hiker/hunter (adult)	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Berry picker (child)	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Berry picker (adult)	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Angler (adult)	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Residential (child)	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Residential (adult)	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Native American (child)	96,592	96,758	93,116	95,434	97,530	97,439	68,966	69,497	58,805	66,134	72,756	72,455
Native American (adult)	165,280	165,563	159,331	163,298	166,884	166,728	118,008	118,917	100,622	113,163	124,493	123,978
Swimmer (child)	57,726	57,825	55,648	57,034	58,286	58,232	41,216	41,533	35,143	39,524	43,481	43,301
Swimmer (adult)	192,829	193,160	185,889	190,517	194,701	194,519	137,678	138,739	117,395	132,026	145,244	144,644

[1] Application rates are shown on Table 4-1 and are the same for each program.
[2] Short-term ARIs are based on incidental oral exposures only. No acute dietary or short term dermal toxicity values available (not toxic via these exposures). Therefore, only the swimming pathways have short term ARIs.
[3] Land type is a parameter used in AgDRIFT® to predict spray drift deposition rates.
[4] Agricul = Agriculture.
[5] Low and high boom applies to a truck-mount or an all-terrain vehicle (ATV)-mount boom.
NC = Not calculated. No dose-response values available.
ARI = Aggregate risk index. Values less than 1 represent a level of concern.

TABLE 5-19
Aggregate Risk Indices for Accidental Exposure Scenarios for Public Receptors Based on Maximum Herbicide Application Rates for Imazapic[1]

Receptor	Dermal Contact Exposure Pathways					Dietary Exposure Pathways						
	Direct Spray of Receptor	Dermal Contact with Foliage	Swimming[2]			Drinking Water Ingestion			Fish Ingestion			Berry Ingestion
			Water Body Spray	Helicopter Spill	Truck Spill	Water Body Spray	Helicopter Spill	Truck Spill	Water Body Spray	Helicopter Spill	Truck Spill	
Angler (adult)	NC	NC	NA	NA	NA	NC	NC	NC	NC	NC	NC	NA
Berry picker (adult)	NC	NC	NA	NA	NA	NC	NC	NC	NA	NA	NA	NC
Berry picker (child)	NC	NC	NA	NA	NA	NC	NC	NC	NA	NA	NA	NC
Hiker/hunter (adult)	NC	NC	NA	NA	NA	NC	NC	NC	NA	NA	NA	NA
Native American (adult)	NC	NC	108,534	969	3,392	NC	NC	NC	NC	NC	NC	NC
Native American (child)	NC	NC	63,429	566	1,982	NC	NC	NC	NC	NC	NC	NC
Residential (adult)	NC	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NC
Residential (child)	NC	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NC
Swimmer (adult)	NA	NA	126,625	1,131	3,957	NA	NA	NA	NA	NA	NA	NA
Swimmer (child)	NA	NA	37,907	338	1,185	NA	NA	NA	NA	NA	NA	NA

[1] Maximum application rate is shown in Table 4-1 and applies to all imazapic application methods.
[2] Includes incidental ingestion for the swimmer.
ARI = Aggregate risk index. Values less than one represent a level of concern.
NA = Receptor not exposed via this pathway.
NC = Not calculated. Imazapic does not have acute dietary or dermal effects.

TABLE 5-20
Aggregate Risk Indices for Routine Short-term Exposure Scenarios for Public Receptors for Sulfometuron Methyl

	Typical Application Rate Scenario ARIs[1,2]				Maximum Application Rate Scenario ARIs[1,2]			
AgDrift Scenario:	**Aerial**	**Aerial**	**Ground**	**Ground**	**Aerial**	**Aerial**	**Ground**	**Ground**
Land Type[3]:	**Agricultural**	**Forestry**	**Both**	**Both**	**Agricultural**	**Forestry**	**Both**	**Both**
Equipment[4]:	**Helicopter**	**Helicopter**	**Low Boom**	**High Boom**	**Helicopter**	**Helicopter**	**Low Boom**	**High Boom**
Hiker/hunter (adult)	NC	NC	NC	NC	NC	NC	NC	NC
Berry picker (child)	NC	NC	NC	NC	NC	NC	NC	NC
Berry picker (adult)	NC	NC	NC	NC	NC	NC	NC	NC
Angler (adult)	NC	NC	NC	NC	NC	NC	NC	NC
Residential (child)	NC	NC	NC	NC	NC	NC	NC	NC
Residential (adult)	NC	NC	NC	NC	NC	NC	NC	NC
Native American (child)	1,325,442	1,161,767	1,471,120	1,457,027	1,121,012	739,184	1,085,942	1,065,574
Native American (adult)	2,267,978	1,987,913	2,517,250	2,493,134	1,918,175	1,264,827	1,858,168	1,823,316
Swimmer (child)	2,256	1,978	2,504	2,480	1,908	1,258	1,849	1,814
Swimmer (adult)	10,517	9,219	11,673	11,562	8,895	5,865	8,617	8,455

[1] Short-term ARIs are based on incidental oral (swimming) pathways only; acute dietary and short term dermal toxicity values are not available (not toxic via these exposures). Therefore, ARIs are calculated only for swimming pathways.
[2] Application rates are shown in Table 4-1 and are the same for each program.
[3] Land type is a parameter used in AgDRIFT to predict spray drift deposition rates.
[4] Low and high boom apply to a truck-mount or an all-terrain vehicle (ATV)-mount boom.
ARI = Aggregate risk index. Values less than one represent a level of concern.
NC = Not calculated. No dose-response values available.
Sulfometuron methyl is not applied via airplane under any program or via helicopter at recreation/cultural sites.

TABLE 5-21
Aggregate Risk Indices for Accidental Exposure Scenarios for Public Receptors Based on Maximum Herbicide Application Rates for Sulfometuron Methyl

Receptor	Dermal Contact Exposure Pathways					Dietary Exposure Pathways						
	Direct Spray of Receptor	Dermal Contact with Foliage	Swimming[2]			Drinking Water Ingestion			Fish Ingestion			Berry Ingestion
			Water Body Spray	Helicopter Spill	Truck Spill	Water Body Spray	Helicopter Spill	Truck Spill	Water Body Spray	Helicopter Spill	Truck Spill	
Angler (adult)	NC	NC	NA	NA	NA	NC	NC	NC	NC	NC	NC	NA
Berry picker (adult)	NC	NC	NA	NA	NA	NC	NC	NC	NA	NA	NA	NC
Berry picker (child)	NC	NC	NA	NA	NA	NC	NC	NC	NA	NA	NA	NC
Hiker/hunter (adult)	NC	NC	NA	NA	NA	NC	NC	NC	NA	NA	NA	NA
Native American (adult)	NC	NC	353,165	3,153	11,036	NC	NC	NC	NC	NA	NA	NC
Native American (child)	NC	NC	206,395	1,843	6,450	NC	NC	NC	NC	NC	NC	NC
Residential (adult)	NC	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NC
Residential (child)	NC	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NC
Swimmer (adult)	NA	NA	1,638	15	51	NA	NA	NA	NA	NA	NA	NA
Swimmer (child)	NA	NA	351	3.1	11	NA	NA	NA	NA	NA	NA	NA

[1] Maximum application rate is shown in Table 4-1 and applies to all sulfometuron methyl application methods.
[2] Includes incidental ingestion for the swimmer.
ARI = Aggregate risk index. Values less than one represent a level of concern.
NA = Receptor not exposed via this pathway.
NC = Not calculated. Sulfometuron methyl does not have acute dietary or dermal effects.

TABLE 5-22
Comparison of Previous Environmental Impact Statement Herbicide Active Ingredient Toxicity Values to Current Toxicity Values[1]

Parameter	Asulam	Atrazine	Bromacil	Chlorsulfuron	Clopyralid	2,4-D	2,4-DP
Previous Values							
Systemic NOAEL (mg/kg-day)	50[2]	0.38[3]	6.25[3]	5[3]	15[3]	1[3]	5[2]
Reproductive and/or teratogenic NOAEL (mg/kg-day)	50[2]	0.5[4]	12.5[4]	25[4]	75[4]	5[4]	6.25[2]
Cancer slope factor (CSF; mg/kg-day)-1	NA[2]	0.22[5]	0.0038[5]	NA[5]	NA[5]	0.029[5]	NA[2]
Current Values							
Acute dietary population adjusted dose	NA	0.1	NA	NA	0.75	NA	NA
Chronic dietary population adjusted dose	0.36	0.006[6]	0.1	0.02	0.15	0.01[7]	NA
Short-term oral NOAEL	NA	6.25	20	75	75	NA	NA
Intermediate-term oral NOAEL	NA	1.8	20	75	15	NA	NA
Short-term dermal NOAEL	50	6.25[8]	20	75[9]	NA[10]	NA	NA
Intermediate-term dermal NOAEL	50	1.8[8]	20	75[9]	NA[10]	NA	NA
Long-term dermal NOAEL	36	1.8[8]	NA	5[9]	NA[10]	NA	NA
Short-term inhalation NOAEL	50	6.25	20	75[9]	75	NA	NA
Intermediate-term inhalation NOAEL	50	1.8	20	75[9]	15	NA	NA
Long-term inhalation NOAEL	36	1.8	NA	5[9]	15	NA	NA
Margin of exposure (MOE)	100	100/300[11]	100	100	100	NA	NA
Cancer slope factor (CSF; mg/kg-day)-1	NA	NA	NA	NA	NA	NA	NA
References	USEPA 2001j	USEPA 2002d	USEPA 1994a	USEPA 2002e	USEPA 2003g	USEPA 2003h	NA

TABLE 5-22 (Cont.)
Comparison of Previous Environmental Impact Statement Herbicide Active Ingredient Toxicity Values to Current Toxicity Values[1]

Parameter	Diuron	Fosamine	Glyphosate	Hexazinone	Imazapyr
Previous Values					
Systemic NOAEL (mg/kg-day)	0.625[3]	25[2]	31[3]	10[3]	500[3]
Reproductive and/or teratogenic NOAEL (mg/kg-day)	6.25[4]	500[2]	10[4]	50[4]	300[4]
Cancer slope factor (CSF; mg/kg-day)-1	NA[5]	NA[2]	0.000024[5]	NA[5]	NA[5]
Current Values					
Acute dietary population adjusted dose	NA	NA	NA	4	NA
Chronic dietary population adjusted dose	0.003	0.01	2	0.05	NA
Short-term oral NOAEL	10	NA	175	NA[12]	NA
Intermediate-term oral NOAEL	1	NA	175	NA[12]	NA
Short-term dermal NOAEL	NA	NA	NA[13]	NA	NA
Intermediate-term dermal NOAEL	NA	1,500	NA[13]	5[14]	NA
Long-term dermal NOAEL	1[15]	NA	NA[13]	5[14]	NA
Short-term inhalation NOAEL	10	NA	NA[13]	100	NA
Intermediate-term inhalation NOAEL	1	NA	NA[13]	5	NA
Long-term inhalation NOAEL	1	NA	NA[13]	5	NA
Margin of exposure (MOE)	100/300[16]	NA	100	100	NA
Cancer slope factor (CSF; mg/kg-day)-1	0.0191	NA	NA	NA	NA
References	USEPA 2001g	USEPA 1994b	USEPA 2002f	USEPA 2002g	NA

TABLE 5-22 (Cont.)
Comparison of Previous Environmental Impact Statement Herbicide Active Ingredient Toxicity Values to Current Toxicity Values[1]

Parameter	Mefluidide	Metsulfuron Methyl	Picloram	Simazine	Tebuthiuron	Triclopyr
Previous Values						
Systemic NOAEL (mg/kg-day)	1.5[3]	25[3]	7[3]	5[3]	12.5[3]	2.5[3]
Reproductive and/or teratogenic NOAEL (mg/kg-day)	60[4]	25[4]	50[4]	5[4]	5[4]	10[4]
Cancer slope factor (CSF; mg/kg-day)-1	NA[5]	NA[5]	0.003[5]	0.083[5]	NA[5]	NA[5]
Current Values						
Acute dietary population adjusted dose	NA	NA	NA	NA	0.25[17]	NA
Chronic dietary population adjusted dose	0.015	0.25	0.2	0.005[18]	0.07[7]	0.005[19]
Short-term oral NOAEL	NA	34	NA	NA	NA	30[20]
Intermediate-term oral NOAEL	NA	34	NA	NA	NA	30[20]
Short-term dermal NOAEL	1.5[21]	125	NA[22]	NA[23]	NA	NA[24]
Intermediate-term dermal NOAEL	1.5[21]	125	NA[22]	NA[23]	NA	NA[24]
Long-term dermal NOAEL	1.5[21]	125	NA[22]	NA[25]	NA	0.5
Short-term inhalation NOAEL	1.5	34	NA[22]	NA[26]	NA	NA[27]
Intermediate-term inhalation NOAEL	1.5	34	NA[22]	NA[26]	NA	NA[27]
Long-term inhalation NOAEL	1.5	25	NA[22]	NA[25]	NA	NA[27]
Margin of exposure (MOE)	100	100	NA	NA	NA	NA
Cancer slope factor (CSF; mg/kg-day)-1	NA	NA	NA	0.12	NA	NA
References	USEPA 2003g	USEPA 2002h	USEPA 1998c	USEPA 1996b	USEPA 2002i	USEPA 1996c

TABLE 5-22 (Cont.)
Comparison of Previous Environmental Impact Statement Herbicide Active Ingredient Toxicity Values to Current Toxicity Values

[1] Section 5.4 of the text describes how the values were compared.
[2] NOAELs for systemic and reproductive effects listed in Appendix H of BLM 1988.
[3] NOAEL for systemic (noncarcinogenic) effects identified in Table E3-4 (BLM 1991).
[4] NOAEL for reproductive and/or teratogenic effects identified in Table E3-4 (BLM 1991).
[5] CSFs listed in BLM 1991 in individual herbicide write-ups.
[6] Based on RfD of 0.018 mg/kg-day and FQPA SF of 3.
[7] RfD listed in IRIS and USEPA 2003d. Based on NOAEL of 1 mg/kg-day (2,4-D), 8.5 mg/kg-day (dalapon), 3 mg/kg-day (dicamba), and 7 mg/kg-day (tebuthiuron).
[8] This value is modified using a dermal absorption factor of 6% in the exposure calculations.
[9] Absorption via the dermal and inhalation routes is assumed to be equivalent to oral absorption.
[10] No dermal or systemic toxicity observed in a 21-day dermal study.
[11] 100 for occupational, 300 for residential due to FQPA SF of 3.
[12] These NOAELs are not listed in the USEPA 2002h document because of the lack of residential pathways.
[13] No hazard was identified through the dermal or inhalation routes.
[14] This value is modified using a dermal absorption factor of 12.5% in the exposure calculations.
[15] This value is modified using a dermal absorption factor of 4% in the exposure calculations.
[16] 300 for long-term dermal and inhalation due to use of a LOAEL. 100 for other pathways.
[17] Based on developmental toxicity NOAEL of 25 mg/kg-day.
[18] The RfD is based on a NOAEL of 0.52 mg/kg-day.
[19] RfD based on NOAEL of 0.5 mg/kg-day.
[20] Based on developmental toxicity NOAEL.
[21] Assumed 100% absorption for dermal and inhalation route-to-route extrapolation.
[22] No toxicity observed in 21-day dermal studies; acute studies show low toxicity and exposure for the inhalation route.
[23] No toxicity observed in a 21-day dermal study in rabbits.
[24] No toxicity seen in 21-day dermal toxicity study in rabbits.
[25] These long-term inhalation and dermal risks are to be assessed using the RfD and assuming 50% absorption for inhalation and 32% absorption for dermal exposures.
[26] Short-term and intermediate-term risk from inhalation exposure is not identified as a concern.
[27] Inhalation toxicity is low; therefore an inhalation risk assessment is not required by agency.
NA = Not available.
CSF = Cancer slope factor.
FQPA SF = Food Quality Protection Act safety factor.
IRIS = Integrated risk information system.
NOAEL = No observed adverse effect level (USDI BLM 1991 used the acronym NOEL to define this term).
RfD = Reference dose.

TABLE 5-23
Comparison of Public Receptors Evaluated

Current Risk Assessment		Previous Risk Assessment[1]	
Receptor	**Pathway**	**Receptor**	**Pathway**
Hiker/hunter	Dermal contact Dermal contact with foliage Ingestion of drinking water	Hiker	Dermal contact Dermal contact with foliage Ingestion of drinking water
Berry picker – child and adult	Dermal contact Dermal contact with foliage Ingestion of drinking water Ingestion of berries	Berrypicker	Dermal contact Dermal contact with foliage Ingestion of drinking water Ingestion of berries
Angler	Dermal contact Dermal contact with foliage Ingestion of drinking water Ingestion of fish	Angler	Dermal contact Dermal contact with foliage Ingestion of drinking water Ingestion of fish
Swimmer - Child and adult	Dermal contact with water while swimming Ingestion of water while swimming	NA	NA NA
Nearby resident – child and adult	Dermal contact Dermal contact with foliage Ingestion of berries	Nearby resident	Dermal contact Dermal contact with foliage NA
Native American – child and adult	Dermal contact Dermal contact with Foliage Dermal contact with water while swimming Ingestion of drinking water Ingestion of berries Ingestion of fish NA	Native American gatherers	Dermal contact Dermal contact with foliage NA Ingestion of drinking water Ingestion of berries Ingestion of fish Ingestion of game

[1] USDI BLM (1991: Appendices. Section E.4.).

6.0 SUMMARY AND CONCLUSIONS

The HHRA has been conducted as part of the PEIS to evaluate potential risks to human health that may result from exposure to the herbicide a.i. both during and after treatment of public lands. The HHRA has evaluated the following six herbicide a.i.:

- Dicamba (formulated with diflufenzopyr)
- Diflufenzopyr (formulated with dicamba)
- Diquat
- Fluridone
- Imazapic
- Sulfometuron methyl

These a.i. may be formulated into herbicides under a variety of trade names and manufacturers. Therefore, specific trade names and manufacturers are not discussed in this report, other than to provide reference herbicide labels (Appendix A).

Based on discussions among the BLM, the USEPA, and ENSR, the HHRA approach was updated from the previous BLM EISs (conducted on 1986, 1988, 1991, and 1992) to ensure that it is scientifically defensible, consistent with currently available guidance where appropriate, and meets the needs of the BLM vegetation treatment program.

The HHRA follows the four-step risk assessment paradigm as identified by NAS (1983):

- Hazard Identification
- Dose-response Assessment
- Exposure Assessment
- Risk Characterization

6.1 Hazard Identification

The Hazard Identification section provides information on the herbicide a.i. characteristics and usage, and toxicity profiles. The toxicity profiles include information on acute, subchronic, and chronic toxicity studies, reproductive and developmental toxicity studies, results of cancer bioassays, mutagenesis, and metabolism. The USEPA has developed toxicity categories for pesticides based on acute toxicity animal tests conducted as part of the process of pesticide registration. The toxicity categories are I, II, III and IV representing severe, moderate, slight and very slight toxicity. The criteria considered are oral, inhalation, and dermal acute toxicity, eye irritation, skin irritation and dermal sensitization. For most of the criteria, the herbicide a.i. are in toxicity categories III and IV. Dicamba is in toxicity category II for acute dermal and eye irritation. Diquat is in toxicity category II for acute dermal and eye irritation, and fluridone is in toxicity category II for eye irritation. The USEPA has not developed acute toxicity categories for sulfometuron methyl. None of the six herbicide a.i. are designated as potential carcinogens by the USEPA.

6.2 Dose-Response Assessment

For pesticide risk assessments, noncarcinogenic effects are evaluated differently depending on whether the exposure is dietary or non-dietary. Dietary exposures are evaluated by dividing site-specific herbicide a.i. intakes by a PAD. The results are expressed as %PADs. The %PAD approach was used to evaluate public receptor ingestion of drinking water, berries, and fish. Non-dietary exposures are evaluated by dividing a NOAEL by the site-specific intake to

calculate a MOE. The MOEs are typically compared to a target MOE of 100, unless specified otherwise. NOAELs are available for a variety of exposure durations and exposure routes. The NOAEL approach is used to evaluate the occupational receptors and the public receptors for the following scenarios: dermal contact with spray, dermal contact with foliage, dermal contact with water while swimming, and incidental ingestion of water while swimming.

For each of the six herbicide a.i. evaluated in this HHRA, the USEPA has developed NOAELs for a majority, but not all, of exposure durations and exposure routes. For dicamba, diflufenzopyr, diquat, and imazapic, the USEPA provided documents (such as reports from the Hazard Identification Assessment Review Committee and HED) showing the derivation of various PADs and NOAELs for different exposure routes and time frames (short-, intermediate- and long-term). At the BLM's request, the USEPA reviewed the available toxicity information for fluridone (USEPA 2003a) and sulfometuron methyl (USEPA 2003b), and developed PADs and NOAELs for oral, dermal, and inhalation exposures.

6.3 Exposure Assessment

The exposure assessment involves identifying receptors and exposure scenarios and quantifying exposures. To understand how humans may be exposed to herbicide a.i. as a result of the BLM vegetation treatment program, it is necessary to understand herbicide use within the BLM. Within the BLM vegetation treatment program, public lands are classified into various land programs (rangeland, public domain forestland, energy and minerals sites, ROW, recreation and cultural sites, and aquatic sites). Within each program, aerial-, ground- or boat-based applications may be used. Various application vehicles can be used for each application type, and for each vehicle, there are different application methods. Similarly, there are different BLM job descriptions associated with each application method. It is assumed that occupational receptors may be incidentally exposed to the herbicide a.i. used through dermal contact and inhalation exposure routes. In addition, an accidental spill scenario was evaluated for the occupational receptors, assuming a direct spill of herbicide a.i. on the skin.

Members of the public may also be incidentally exposed to herbicide a.i. used on public lands. Such receptors include hikers, hunters, berry pickers, swimmers, anglers, area residents, and Native Americans using natural resources on public lands. Although there are many different exposure scenarios and receptors that could be evaluated, these receptors cover a range of potential exposures that could occur under worst case conditions on BLM lands. It is assumed that these receptors could be exposed through one or more of the following exposure pathways:

- Dermal contact with spray
- Dermal contact with foliage
- Dermal contact with water while swimming
- Ingestion of drinking water or incidental ingestion of water while swimming
- Ingestion of berries
- Ingestion of fish

Although all public receptor exposures to herbicide a.i. used on public lands are considered to be accidental, public receptor exposures are evaluated under two scenarios. Routine-use exposures are assumed to occur when public receptors come into contact with environmental media that have been impacted by spray drift. Dose-response values are available for short-, intermediate-, and long-term exposures. While it is possible that public receptors use public lands under intermediate- and long-term time frames, it is unlikely that public receptors would be exposed to herbicides under the routine use scenario for more than a short-term exposure, which is defined as 1 day to 1 month (USEPA 2001h). Therefore, short-term dose-response values were used to evaluate the public receptors under the routine use exposure scenario. An evaluation of the public receptors under an intermediate- and a long-term exposure scenario is included in the Uncertainty Analysis (Section 5.5).

Accidental exposures are assumed to occur when public receptors come into contact with environmental media that have been subject to direct spray or spills. Under the direct spray scenarios, it is assumed that a receptor enters a foliated area or a pond (for the aquatic herbicide a.i.) that has recently been treated, even though the area is posted with warning signs. The direct spray pathway for terrestrial herbicide a.i. onto ponds assumes that the herbicide a.i. are accidentally sprayed on the pond.

To quantify exposures, it is necessary to estimate the herbicide a.i. concentrations to which receptors could be exposed. For the occupational receptors, routine exposures were calculated using UE values developed by the USEPA combined with the herbicide a.i. ARs and the AT per day. Accidental exposures were calculated using the undiluted herbicide a.i. concentrations for liquid formulations and application-ready concentrations for solid formulations, and assuming a certain amount of spill and absorption through the skin.

For the public receptors, routine exposures from spray drift were calculated using EPCs developed using computer models. The AgDRIFT® model was used to estimate deposition of herbicide a.i. drift onto the receptor, foliage, berries, and pond. The GLEAMS model was used to calculate herbicide a.i. concentrations in the pond resulting from runoff (short-, intermediate- and long-term exposure durations). For the three terrestrial herbicide a.i., pond concentrations calculated in AgDRIFT® were added to the highest pond concentrations calculated in GLEAMS. Accidental exposures were calculated assuming direct spray of the herbicide a.i. at the maximum ARs onto the receptor, foliage, berries, and pond. In addition, an accidental spill scenario was evaluated for the pond assuming that the entire contents of a truck or helicopter could spill into the pond.

6.4 Risk Characterization

The risk characterization section provides quantitative risk estimates for each of the herbicide a.i. for the various receptors and exposure scenarios. The USEPA's Office of Pesticides Program has developed an ARI approach that combines risks calculated using the %PAD and MOE methods. As with the MOE, potential risk increases as the ARI decreases. The ARI is compared against a target value of 1. Values greater than 1 do not exceed the USEPA's level of concern.

Table 6-1 shows the scenarios and herbicide a.i. resulting in ARIs less than 1 for the occupational receptors. As shown in Table 6-1, under the routine use, typical AR scenario, diquat results in ARIs less than 1 for the majority of the exposure periods. Under the routine use, maximum AR scenario, diquat results in ARIs less than 1 for all exposure scenarios for all occupational receptors. Under the routine use, maximum AR scenario for fluridone, ARIs for an airplane mixer/loader (intermediate- and long-term exposure) and helicopter mixer/loader (long-term exposure) are less than 1. Under the accidental spill scenario for the occupational receptors, dicamba, diquat and fluridone result in ARIs below 1 for all of the occupational receptors under the concentrated liquid (diquat and fluridone only), maximum AR, and typical AR scenarios. The other three herbicide a.i. (diflufenzopyr, imazapic, and sulfometuron methyl) do not result in ARIs below 1 for any scenario.

Table 6-2 shows the routine use scenarios and herbicide a.i. resulting in ARIs less than 1 for the public receptos. Diquat results in ARIs below 1 for the residential child under the typical AR scenario. Under the maximum AR scenarios, diquat results in ARIs below 1 for the majority of scenarios.

Table 6-3 presents a summary of accidental use scenarios and herbicide a.i. resulting in ARIs less than 1 for the public receptors. Diquat results in ARIs below 1 for all receptors via direct spray and dermal contact with foliage, for the berry picker (child) via drinking water from a pond receiving a truck spill at the maximum AR, and for the following receptors via drinking water from a pond receiving a helicopter spill at the maximum AR:

- Hiker/hunter
- Berry picker (child) – ARI is also less than one for a helicopter spill at the typical AR
- Berry picker (adult)

- Angler
- Native American (child)

Fluridone results in accidental scenario (maximum AR) ARIs below 1 for the berry picker child, residential child, and Native American child scenario exposed to direct spray; and for the residential child exposed via dermal contact with foliage. Under the typical AR, the ARI is equal to or above 1. ARIs for dicamba, diflufenzopyr, imazapic, and sulfometuron methyl are all greater than 1 for both the routine and accidental scenarios, indicating no significant risk.

These results show that diflufenzopyr, imazapic, and sulfometuron methyl do not pose unacceptable risks for any of the exposure scenarios. Dicamba does not pose unacceptable risks for any scenario, except for the accidental spill scenario for the occupational receptor.

TABLE 6-1
Occupational Scenarios with Aggregate Risk Indices Below One[1]

Application Type	Application Vehicle	Application Method	Receptor	Typical Application Rate Scenario ARIs			Maximum Application Rate Scenario ARIs			Accidental Scenario ARIs[2]
				Short Term	Intermediate Term	Long Term	Short Term	Intermediate Term	Long Term	Short Term (Dermal)
Aerial	Plane	Fixed Wing	Pilot	Diquat	Diquat	Diquat	Diquat	Diquat	Diquat	Dicamba, diquat, fluridone
Aerial	Plane	Fixed Wing	Mixer/loader	Diquat	Diquat	Diquat	Diquat	Diquat, fluridone	Diquat, fluridone	Dicamba, diquat, fluridone
Aerial	Helicopter	Rotary	Pilot	Diquat	Diquat	Diquat	Diquat	Diquat	Diquat	Dicamba, diquat, fluridone
Aerial	Helicopter	Rotary	Mixer/loader	Diquat	Diquat	Diquat	Diquat	Diquat	Diquat, fluridone	Dicamba, diquat, fluridone
Ground	Human	Backpack	Applicator/mixer/loader	Diquat	Diquat	Diquat	Diquat	Diquat	Diquat	Dicamba, diquat, fluridone
Ground	Human	Horseback	Applicator	Diquat	Diquat	Diquat	Diquat	Diquat	Diquat	Dicamba, diquat, fluridone
Ground	Human	Horseback	Mixer/loader	No ARI<1	No ARI<1	No ARI<1	Diquat	Diquat	Diquat	Dicamba, diquat, fluridone
Ground	Human	Horseback	Applicator/mixer/loader	Diquat	Diquat	Diquat	Diquat	Diquat	Diquat	Dicamba, diquat, fluridone
Ground	ATV	Spot	Applicator	No ARI<1	Diquat	Diquat	Diquat	Diquat	Diquat	Dicamba, diquat, fluridone
Ground	ATV	Spot	Mixer/loader	No ARI<1	No ARI<1	No ARI<1	Diquat	Diquat	Diquat	Dicamba, diquat, fluridone
Ground	ATV	Spot	Applicator/mixer/loader	Diquat	Diquat	Diquat	Diquat	Diquat	Diquat	Dicamba, diquat, fluridone
Ground	ATV	Boom/**b**roadcast	Applicator	No ARI<1	No ARI<1	No ARI<1	Diquat	Diquat	Diquat	Dicamba, diquat, fluridone[3]
Ground	ATV	Boom/**b**roadcast	Mixer/loader	No ARI<1	No ARI<1	No ARI<1	Diquat	Diquat	Diquat	Dicamba, diquat, fluridone[3]
Ground	ATV	Boom/**b**roadcast	Applicator/mixer/loader	No ARI<1	No ARI<1	No ARI<1	Diquat	Diquat	Diquat	Dicamba, diquat, fluridone[3]
Ground	Truck mount	Spot	Applicator	Diquat	Diquat	Diquat	Diquat	Diquat	Diquat	Dicamba, diquat, fluridone
Ground	Truck mount	Spot	Mixer/loader	No ARI<1	No ARI<1	No ARI<1	Diquat	Diquat	Diquat	Dicamba, diquat, fluridone
Ground	Truck mount	Spot	Applicator/mixer/loader	Diquat	Diquat	Diquat	Diquat	Diquat	Diquat	Dicamba, diquat, fluridone
Ground	Truck mount	Boom/**b**roadcast	Applicator	No ARI<1	No ARI<1	No ARI<1	Diquat	Diquat	Diquat	Dicamba, diquat, fluridone[3]
Ground	Truck mount	Boom/**b**roadcast	Mixer/loader	No ARI<1	No ARI<1	No ARI<1	Diquat	Diquat	Diquat	Dicamba, diquat, fluridone[3]
Ground	Truck mount	Boom/**b**roadcast	Applicator/mixer/loader	Diquat	Diquat	Diquat	Diquat	Diquat	Diquat	Dicamba, diquat, fluridone[3]
Aquatic	Boat	Spot	Applicator	No ARI<1	No ARI<1	No ARI<1	No ARI<1	No ARI<1	No ARI<1	Dicamba, diquat, fluridone
Aquatic	Boat	Spot	Mixer/loader	No ARI<1	No ARI<1	No ARI<1	No ARI<1	No ARI<1	No ARI<1	Dicamba, diquat, fluridone
Aquatic	Boat	Spot	Applicator/mixer/loader	No ARI<1	No ARI<1	No ARI<1	No ARI<1	No ARI<1	No ARI<1	Dicamba, diquat, fluridone
Aquatic	Boat	Boom/**b**roadcast	Applicator	No ARI<1	No ARI<1	No ARI<1	No ARI<1	No ARI<1	No ARI<1	Dicamba, diquat, fluridone[3]
Aquatic	Boat	Boom/**b**roadcast	Mixer/loader	No ARI<1	No ARI<1	No ARI<1	No ARI<1	No ARI<1	No ARI<1	Dicamba, diquat, fluridone[3]
Aquatic	Boat	Boom/**b**roadcast	Applicator/mixer/loader	No ARI<1	No ARI<1	No ARI<1	No ARI<1	No ARI<1	No ARI<1	Dicamba, diquat, fluridone[3]

[1] ARI values less than one indicate a level of concern.
[2] Concentrated solution and mixed solutions (maximum application rate and typical application rate).
[3] Boom /broadcast includes both granular and liquid forms of fluridone.

TABLE 6-2
Routine Public Scenarios/Receptors with Aggregate Risk Indices below One[1]

	Routine Exposure Scenarios							
	Typical Application Rate Scenario ARIs				Maximum Application Rate Scenario ARIs			
AgDRIFT Scenario:	**Aerial**	**Aerial**	**Ground**	**Ground**	**Aerial**	**Aerial**	**Ground**	**Ground**
Land Type[2]:	**Agricultural**	**Agricultural**	**Agricultural**	**Agricultural**	**Agricultural**	**Agricultural**	**Agricultural**	**Agricultural**
Equipment[3]:	**Plane**	**Helicopter**	**Low Boom**	**High Boom**	**Plane**	**Helicopter**	**Low Boom**	**High Boom**
Hiker/hunter (adult)					Diquat	Diquat		
Berry picker (child)					Diquat	Diquat		Diquat
Berry picker (adult)					Diquat	Diquat		Diquat
Angler (adult)					Diquat	Diquat		
Residential (child)	Diquat	Diquat			Diquat	Diquat	Diquat	Diquat
Residential (adult)					Diquat	Diquat	Diquat	Diquat
Native American (child)					Diquat	Diquat		Diquat
Native American (adult)					Diquat	Diquat		
Swimmer (adult)								
Swimmer (child)								

[1] ARI values less than one indicate a level of concern.
[2] Agricultural land type is used as a proxy for a pond for aerial scenarios. Ground scenarios are not differentiated in AgDRIFT® by land type.
[3] Low and high boom apply to a truck mount or a boat mount boom.

TABLE 6-3
Accidental Public Scenarios with Aggregate Risk Indices below One[1]

Receptor	Accidental Exposure Scenarios					
	Direct Spray of Receptor	Dermal Contact with Foliage	Swimming		Drinking Water Ingestion	
			Helicoptor Spill	Truck Spill	Helicoptor Spill	Truck Spill
Hiker/hunter (adult)	Diquat (M,T)[2]	Diquat (M)	NA	NA	Diquat (M)	No ARI<1
Berry picker (child)	Diquat (M,T) Fluridone (M)	Diquat (M)	NA	NA	Diquat (M,T)	Diquat (M)
Berry picker (Adult)	Diquat (M,T)	Diquat (M)	NA	NA	Diquat (M)	No ARI<1
Angler (adult)	Diquat (M,T)	Diquat (M)	NA	NA	Diquat (M)	No ARI<1
Residential (child)	Diquat (M,T) Fluridone (M)	Diquat (M,T) Fluridone (M)	NA	NA	NA	No ARI<1
Residential (adult)	Diquat (M,T)	Diquat (M,T)	NA	NA	NA	No ARI<1
Native American (child)	Diquat (M,T) Fluridone (M)	Diquat (M)	NA	NA	Diquat (M)	No ARI<1
Native American (adult)	Diquat (M,T)	Diquat (M)	NA	NA	No ARI<1	No ARI<1
Swimmer (child)	NA	NA	Diquat (M,T)	Diquat (M,T)	NA	NA
Swimmer (adult)	NA	NA	Diquat (M)	Diquat (M)	NA	NA

[1] ARI values less than one indicate a level of concern.
[2] T = Typical application rate scenario; and M = maximum application rate scenario.
NA = Receptor not exposed via this pathway.

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